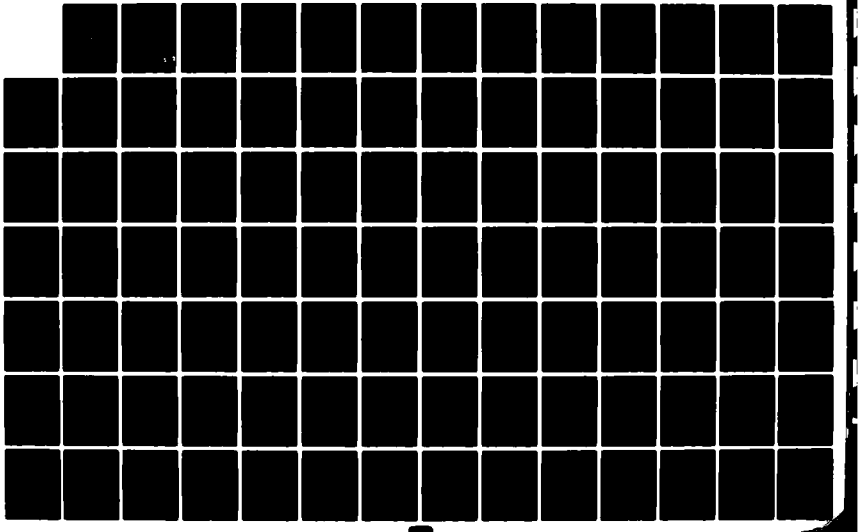
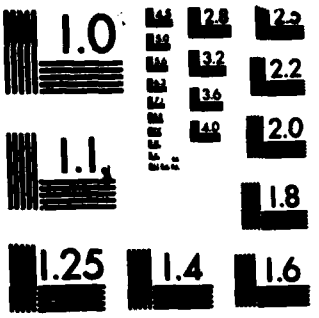
AD-A140 871 COMMAND FLIGHT PATH DISPLAY PHASE I AND II APPENDICES A 1/2
- E(U) CALSPAN CORP SAN DIEGO CA SEP 83
CALSPAN-6645-F-12-APP-A-E F33615-79-C-3618

UNCLASSIFIED F/G 9/2 NL





COMMAND FLIGHT PATH DISPLAY

PHASE I AND II

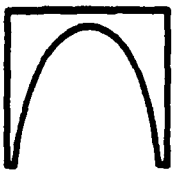
FINAL TECHNICAL REPORT

R83-49

(Appendices A - E)

SYSTEMS ASSOCIATES, INC.
of
CALIFORNIA

Resource Management Systems Division



853 Atlantic Avenue
Long Beach, California 90813
Telephone 213/435-8282

COMMAND FLIGHT PATH DISPLAY

PHASE I AND II

FINAL TECHNICAL REPORT

R83-49

(Appendices A - E)

SEPTEMBER 1983

F33615-79-C-3618

S-82-03

SAI-83-01

UNCLASSIFIED

APPENDIX A

Command Flight Path Display

Schedule Summary

Ground simulation of the Command Flight Path Display System commenced on January 27, 1983, and continued through April 20, 1983. Approximately ninety-one (91) hours of simulation were accumulated during this timeframe. The simulation flights involved display parameter changes and adjustments, introduction and preparation of pilots for the actual flight test, and demonstration flights. A breakdown of the simulation ~~follows.~~ is presented in this report.

SIMULATION HISTORY

Date	VSI Type	Pilots	Approx. Time
1/27/83	Xytron	G. Hoover C. Berthe V. Cronauer	3 hrs.
1/28/83	Xytron HUD	N. Infanti C. Berthe G. Hoover V. Cronauer S. Shelley	6 hrs.
1/31/83	Xytron	G. Hoover V. Cronauer	7 hrs.
2/1/83	Xytron	V. Cronauer R. Harper G. Hoover N. Infanti	8 hrs.
2/2/83	Xytron	G. Hoover V. Cronauer	7 hrs.
2/3/83	Xytron HUD	N. Infanti R. Harper V. Cronauer	7 hrs.
2/8/83	Xytron HUD	G. Hoover V. Cronauer	6 hrs.
2/9/83	Xytron	G. Hoover	2 hrs.
2/22/83	HUD	G. Hoover T. Parady V. Cronauer M. Parrag	6 hrs.
2/23/83	Xytron	B. Eulrich N. Akiyama T. Gavin	5 hrs.
2/24/83	Xytron	N. Infanti C. Berthe J. Dittenhauser V. Cronauer	4 hrs.
3/3/83	Xytron	J. Wetherbee K. Stein	2 hrs.
3/7/83	Xytron	R. O'Hanlon	2 hrs.

SIMULATION HISTORY - Page 2

Date	VSI Type	Pilots	Approx. Time
3/9/83	Xytron	J. Walters	2 hrs.
3/10/83	HUD	J. Walters J. Ball	2 hrs.
3/21/83	Xytron	G. Hoover V. Cronauer	5 hrs.
3/22/83	HUD	G. Hoover S. Shelley B. Eulrich J. Hooper V. Cronauer	6 hrs.
3/24/83	HUD	F. Ameel	1 hr.
4/18/83	HUD	G. Hoover S. Gilbert V. Cronauer S. Shelley K. Cameron B. Watkins	7 hrs.
4/19/83	HUD	E. R. Seymour R. D. Friichtenicht	2 hrs.
		TOTAL:	91 hrs.

The first flight on the Command Flight Path Display was originally planned for 1 February 1983. Air Force approval of the Class II Part II Modification of TIFS, required prior to flight, was not received until verbal notification on 8 February 1983. The first flight on the Command Flight Path Display System was accomplished the following day, 9 February 1983, with Mr. George Hoover flying. A breakdown of the actual flights on the Command Flight Path Display System follows.

CFPD FLIGHT NUMBER: 01

DATE: 9 February 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: G. Hoover

Evaluation Pilot #2: R. P. Harper

CFPD Engineer #1: S. Shelley

CFPD Engineer #2: N. Akiyama

Calspan Flight No. : 709

Pilot-In-Command : C. J. Berthe, Jr.

Pilot : J. F. Ball

Test Engineer : J. Dittenhauser

TAKEOFF: 1546 TOUCHDOWN: 1736

BUFFALO WX: 250 @ 20 11/6 30.17

IAG WX : 20 @ 250 @ 10 12/08

WINDS : Surface: 360/5

: 6000 ft.: 340/12-15

:

Sequence of Flight Test:

EP 1 Partial Pattern-CFPD Cockpit Masked

EP 2 Pattern-CFPD Cockpit Masked

CFPD FLIGHT NUMBER: 02

DATE: 10 February 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: R. P. Harper

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: S. Shelley

CFPD Engineer #2: N. Akiyama

Calspan Flight No. : 710

Pilot-In-Command : C. J. Berthe, Jr.

Pilot : J. F. Ball

Test Engineer : J. Dittenhauser

TAKEOFF: 1430 TOUCHDOWN: 1630

BUFFALO WX: _____

IAG WX : _____

WINDS : _____

: _____

: _____

Sequence of Flight Test:

EP 1 Pattern - CFPD Cockpit Masked

EP 1 Partial Pattern-Symbology Cockpit Masked

EP 1 Pattern - Symbology Cockpit Masked

EP 2 Partial Pattern-CFPD Cockpit Masked

CFPD FLIGHT NUMBER: 03

DATE: 3 March 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: Lt. J. Wetherbee

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: S. Shelley

CFPD Engineer #2: P. Slonaker

Calspan Flight No. : 712

Pilot-In-Command : M. L. Parrag

Pilot : J. F. Ball

Test Engineer : T. Gavin

TAKEOFF: 1505 TOUCHDOWN: 1715

BUFFALO WX: 18 ● 15 43/29 310/8 30.02

IAG WX : 35 ● 250 ● 15 41/27 290/8 3002

WINDS :

:

:

Sequence of Flight Test:

EP 1 Pattern - Symbology Cockpit Masked

EP 1 Pattern - CFPD Cockpit Masked

EP 1 Approach - Symbolology Cockpit Masked

EP 1 Approach - CFPD Cockpit Masked

CFPD FLIGHT NUMBER: 04

DATE: 4 March 1983 VSI TYPE: HUGHES HUD

Evaluation Pilot #1: Lt. J. Wetherbee

Evaluation Pilot #2: R. P. Harper

CFPD Engineer #1: S. Shelley

CFPD Engineer #2: P. Slonaker

Calspan Flight No. : 713

Pilot-In-Command : M. L. Parrag

Pilot : J. F. Ball

Test Engineer : T. Gavin

TAKEOFF: 1121 TOUCHDOWN: 1328

BUFFALO WX: 4 ● 5 ● 70 ● 8 40/34 070/9 29.89

IAG WX : 50 ● 80 ● 7 41/34 100/10

WINDS : 3000 ft. 190/8

: 6000 ft. 260/19

: 9000 ft. 180/29

Sequence of Flight Test:

EP 1 Approach - CFPD Cockpit Masked

EP 1 Approach - CFPD Cockpit Unmasked

EP 1 Pattern - Symbology Cockpit Masked

EP 1 Pattern - CFPD Cockpit Masked
(unmasked for 5 minutes)

EP 1 Approach - Symbology Cockpit Masked

CFPD FLIGHT NUMBER: 05

DATE: 7 March 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: Lt. R. O'Hanlon

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: N. Akiyama

CFPD Engineer #2:

Calspan Flight No. : 714

Pilot-In-Command : C. J. Berthe, Jr.

Pilot : J. F. Ball

Test Engineer : T. Gavin

TAKEOFF: 1440 TOUCHDOWN: 1626

BUFFALO WX: 210 @ 25 70/49 120/09 29.79

IAG WX : 160 @ 210 @ 250 @ 15 68/45 120/12 29.78

WINDS : 6000 - 9000 200/20

:

:

Sequence of Flight Test:

EP 1 Approach - CFPD Cockpit Masked

EP 1 Approach - Symbology Cockpit Masked

EP 1 Pattern - Symbology Cockpit Masked

EP 1 Pattern - CFPD Cockpit Masked

EP 1 Approach - CFPD Cockpit Masked

CFPD FLIGHT NUMBER: 06

DATE: 8 March 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: Lt. R. O'Hanlon

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: N. Akiyama

CFPD Engineer #2:

Calspan Flight No. : 715

Pilot-In-Command : C. J. Berthe, Jr.

Pilot : J. F. Ball

Test Engineer : T. Gavin

TAKEOFF: 1154 TOUCHDOWN: 1335

BUFFALO WX: 30 @ 65 @ 180 @ 20 50/44 29.23

IAG WX : 30 @ 80 @ 200 @ 7 110/10

WINDS :

:

:

Sequence of Flight Test:

EP 1 Pattern - CFPD Cockpit Masked

EP 1 Pattern - Symbology Cockpit Masked

EP 1 Approach- Symbology Cockpit Masked

EP 1 Approach- CFPD Cockpit Masked

EP 2 Approach - CFPD Cockpit Masked

NOTE: Slight to moderate turbulence encountered during flight.

CFPD FLIGHT NUMBER: 07

DATE: 9 March 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: LCDR J. Walters

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: N. Akiyama

CFPD Engineer #2: _____

Calspan Flight No. : 716

Pilot-In-Command : C. J. Berthe, Jr.

Pilot : J. F. Ball

Test Engineer : T. Gavin

TAKEOFF: 1420 TOUCHDOWN: 1530

BUFFALO WX: 3 @ 5 @ 2 LF⁻ 43/40 210/12 29.72

IAG WX : 1 @ 4 @ 2 LF⁻ 220/9 29.75

WINDS : _____

: _____

: _____

Sequence of Flight Test:

EP 1 Pattern - CFPD Cockpit Unmasked

EP 1 Pattern - Symbology Cockpit Unmasked

NOTE: CFPD Velocity Indicator Uncoupled - Actual IFR Conditions.

CFPD FLIGHT NUMBER: 08

DATE: 23 March 1983 VSI TYPE: HUGHES HUD

Evaluation Pilot #1: LCDR Walters

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: S. Shelley

CFPD Engineer #2: _____

Calspan Flight No. : 717

Pilot-In-Command : M. L. Parrag

Pilot : J. F. Ball

Test Engineer : T. Gavin

TAKEOFF: 1043 TOUCHDOWN: 1250

BUFFALO WX : 25 @ 20 260/14

IAG WX : 270/13

WINDS : 6000 ft. 270/35

: 9000 ft. 270/40

:

Sequence of Flight Test:

EP 1 Pattern - CFPD Cockpit Unmasked

EP 1 Pattern - Symbology Cockpit Masked

EP 1 Approach - Symbology Cockpit Unmasked

EP 1 Approach - Symbology Cockpit Masked

EP 1 Approach - CFPD Cockpit Unmasked

EP 1 Approach - CFPD Cockpit Masked

NOTE: Velocity Indicator Uncoupled

CFPD FLIGHT NUMBER: 09

DATE: 24 March 1983 VSI TYPE: HUGHES HUD

Evaluation Pilot #1: CDR F. Ameel

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: S. Shelley

CFPD Engineer #2:

Calspan Flight No. : 718

Pilot-In-Command : M. L. Parrag

Pilot : J. F. Ball

Test Engineer : T. Gavin

TAKEOFF: 1244 TOUCHDOWN: 1443

BUFFALO WX: 15 @ 45 @ V @ 310/8

IAG WX :OCCN 15 @ 1 SW- CH 5X 314SW-BS 350/11

WINDS : 3000 ft. 320/17

: 6000 ft. 310/23

: 9000 ft. 310/30

Sequence of Flight Test:

EP 1 Pattern - Symbology Cockpit Masked

EP 1 Pattern - CFPD Cockpit Masked

EP 1 Approach- Symbology Cockpit Unmasked

EP 1 Approach- Symbology Cockpit Masked

EP 1 Approach- CFPD Cockpit Masked

EP 1 Approach- CFPD Cockpit Unmasked

CFPD FLIGHT NUMBER: 10

DATE: 19 April 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: VADM. E. R. Seymour

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: S. Shelley

NADC Photographer : R. Barcklow

Calspan Flight No. : 719

Pilot-In-Command : C. J. Berthe, Jr.

Pilot : M. L. Parrag

Test Engineer : T. Gavin

TAKEOFF: 0935 TOUCHDOWN: 1121

BUFFALO WX: 12 @ 19 @ 1 1/2 S- 29/25 060/9 29.76

IAG WX : 8 @ 25 @ 6 S- 31/24 080/10 29/78

WINDS : 6000 - 9000 350/14

:

:

Sequence of Flight Test:

EP 1 Pattern - CFPD Cockpit Unmasked

EP 1 Pattern - Symbology Cockpit Unmasked

EP 1 Approach- Symbology Cockpit Unmasked

EP 1 Approach- CFPD Cockpit Unmasked

CFPD FLIGHT NUMBER: 11

DATE: 19 April 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: Capt. R. D. Friichtenicht

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: S. Shelley

Observer : F. Nelson

Calspan Flight No. : 720

Pilot-In-Command : C. J. Berthe, Jr.

Pilot : M. L. Parrag

Test Engineer : T. Gavin

TAKEOFF: 1530 TOUCHDOWN: 1706

BUFFALO WX: 25 @ 75 @ 20 35 010/14 29.75

IAG WX : 30 @ 100 @ 15

WINDS : 6000 - 9000 340/18

: Light Turbulence

:

Sequence of Flight Test:

EP 1 Pattern - CFPD Cockpit Unmasked

EP 1 Pattern - Symbology Cockpit Unmasked

EP 1 Approach- Symbology Cockpit Unmasked

EP 1 Approach- CFPD Cockpit Masked

CFPD FLIGHT NUMBER: 12

DATE: 20 April 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: Maj. Ken Cameron

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: S. Shelley

Observer :

Calspan Flight No. : 721

Pilot-In-Command : M. L. Parrag

Pilot : C. J. Berthe, Jr.

Test Engineer : T. Gavin

TAKEOFF: 0950 TOUCHDOWN: 1131

BUFFALO WX: 10 @ 16 @ 27 @ 15 320/11 29.64

IAG WX : 12 @ 330/13 29.65

WINDS : 6000 020/36

: 9000 030/30

: Light Turbulence

Sequence of Flight Test:

EP 1 Pattern - Symbology Cockpit Unmasked

EP 1 Pattern - CFPD Cockpit Unmasked

EP 1 Approach- CFPD Cockpit Masked

EP 1 Approach- CFPD Cockpit Masked

CFPD FLIGHT NUMBER: 13

DATE: 20 April 1983 VSI TYPE: XYTRON

Evaluation Pilot #1: Lt. B. Watkins

Evaluation Pilot #2: V. T. Cronauer

CFPD Engineer #1: S. Shelley

Observer : EASTER

Calspan Flight No. : 722

Pilot-In-Command : M. L. Parrag

Pilot : C. J. Berthe, Jr.

Test Engineer : T. Gavin

TAKEOFF: 1412 TOUCHDOWN: 1538

BUFFALO WX: -X 15 @ 23 @ 1-2S 36/30 290/15 29/63

IAG WX : 25 @ 60 @ 7 S 270/10 29.64

WINDS : 6000 - 9000 320/25

:

:

Sequence of Flight Test:

EP 1 Pattern - Symbology Cockpit Masked

EP 1 Pattern - CFPD Cockpit Masked

EP 1 Approach- CFPD Cockpit Masked

APPENDIX B

Command Flight Path Display

Cost Analysis

COMMAND FLIGHT PATH DISPLAY

ACTUAL EXPENDITURE OF FUNDS

Month	Arvin/Calspan	SAI/RMS*	Total	Cumulative
MAY	39,000	35,000	74,000	74,000
JUN	56,000	30,000	86,000	160,000
JUL	38,000	35,000	73,000	233,000
AUG	55,000	21,000	76,000	309,000
SEP	160,000	47,000	207,000	516,000
OCT	110,000	56,000	166,000	682,000
NOV	91,000	38,000	129,000	811,000
DEC	51,000	34,000	85,000	896,000
JAN	121,000	36,000	157,000	1,053,000
FEB	62,000	45,000	107,000	1,160,000
MAR	85,000	40,000	125,000	1,285,000
APR	37,000	33,000	70,000	1,355,000
MAY	(6,000)	29,000	23,000	1,378,000
JUN	5,000	27,000	32,000	1,410,000
JUL	3,000	15,000	18,000	1,428,000
AUG	UNK	19,000	19,000	1,447,000**

Original Estimate	25 May 1983	$1,230,000
Revised	3 Sept 1983	$1,465,000

* Includes Intermetrics Inc. and Evans and Sutherland.
** Does not include August figures for Arvin/Calspan.

APPENDIX C

Command Flight Path Display

Meeting Minutes

STATUS REPORT MEETINGS

Status report meetings were conducted on the following dates at NAVAIR to apprise Mr. H. Andrews of program status:

Meeting No.	Date	Location
1	11 May 1982	Arlington, Virginia
2	8 June 1982	Arlington, Virginia
3	20 August 1982	Arlington, Virginia
4	14 September 1982	Arlington, Virginia
5	1 November 1982	Arlington, Virginia
6	16 December 1982	Arlington, Virginia
7	28 February 1983	Arlington, Virginia
8	20 May 1983	Arlington, Virginia

CONCEPT BRIEFINGS

CFPD concept briefings were prepared and presented as follows:

Date	Presented To	Title	Location
14 January 1983	D. Mancinelli	Director of Aircraft and Crew Sys. Tech. NADC	Warminster Pennsylvania
25 January 1983	VADM R.F. Schoultz	Deputy Chief of Naval Operations (Air Warfare)	Pentagon Arlington Virginia
26 January 1983	VADM E.R. Seymour	Commander, Naval Air Systems Command	Arlington Virginia

TEST FLIGHT SUMMARY MEETINGS

CFPD test flight summary meetings were conducted as follows:

Date	Presented To	Title	Location
16 May 1983	VADM R. F. Schoultz	Deputy Chief of Naval Operations (Air Warfare)	Pentagon Arlington Virginia

Date	Presented To	Title	Location
19 May 1983	William H. Gregory	Editor-In-Chief, Aviation Week & Space Technology	Arlington Virginia
20 May 1983	CDR R.R. Wittenberg	OP506C TACAIR Strike System	Pentagon Arlington Virginia

Numerous meetings concerning the Command Flight Path Display System hardware and software requirements were held. The following list details the dates, participants, locations and major topics of the meetings.

PROGRAM MEETINGS ON HARDWARE AND SOFTWARE CONSIDERATIONS

Date	Participants	Location	Topic
19 May 1982	Evans & Sutherland Systems Associates, Inc. of CA	Newport Beach California	CFPD Benchmark PS-300
3 June 1982	Xytron, Inc. Systems Associates, Inc. of CA	Sylmar California	CRTs
21,22 June 1982	Evans & Sutherland Systems Associates, Inc. of CA Intermetrics, Inc.	Newport Beach California	PS-300 Training
28 June 1982	Evans & Sutherland Systems Associates, Inc. of CA Arvin/Calspan	Salt Lake City Utah	PS-300 Ruggedization
29 June 1982	Systems Associates, Inc. of CA Arvin/Calspan Xytron, Inc.	Sylmar California	CRTs
30 June 1982	Systems Associates, Inc. of CA Gemini Associates Miltope	San Diego California	Magtape Recorder
8,9 July 1982	Systems Associates, Inc. of CA Intermetrics, Inc. Evans & Sutherland	Salt Lake City Utah	PS-300 Ruggedization
13 July 1982	Evans & Sutherland Systems Associates, Inc. of CA	San Diego California	PS-300 Ruggedization
28 July 1982	Evans & Sutherland Systems Associates, Inc. of CA	Newport Beach California	PS-300 Firmware

Date	Participants	Location	Topic
2-6 August 1982	Arvin/Calspan Naval Air Development Center Intermetrics, Inc. Systems Associates, Inc. of CA	Farmington Connecticut	PS-300 Training
5 August 1982	Hughes Radar Systems Group Systems Associates, Inc. of CA	Los Angeles California	HUD Interface
23 August 1982	Intermetrics, Inc. Evans & Sutherland	Salt Lake City Utah	PS-300 Firmware
1 September 1982	Hughes Radar Systems Group Naval Air Development Center Systems Associates, Inc. of CA	Los Angeles California	HUD Interface
21 October 1982	Evans & Sutherland Systems Associates, Inc. of CA Arvin/Calspan	Salt Lake City Utah	PS-300 Ruggedization
21 October 1982	Intermetrics, Inc. Arvin/Calspan	Cambridge Massachusetts	Sensor Software
22 October 1982	Hughes Radar Systems Group Systems Associates, Inc. of CA Arvin/Calspan	Los Angeles California	HUD Interface

PROGRAM REVIEW MEETINGS

Program review meetings were scheduled as necessary to maintain progress and communications. Representatives of the following were in attendance at each meeting:

Naval Air Development Center
Air Force Wright Aeronautical Laboratories
Arvin/Calspan Advanced Technology Center
Systems Associates, Inc. of California
Intermetrics, Inc.

A total of seven (7) review meetings took place as listed:

Meeting No.	Date	Location
1	5,6 May 1982	Buffalo, New York
2	9 June 1982	Cambridge, Massachusetts
3	17,18 August 1982	Buffalo, New York
4	28 September 1982	Cambridge, Massachusetts
5	28 October 1982	Buffalo, New York
6	15 December 1982	Buffalo, New York
7	27 January 1983	Buffalo, New York

The minutes of the review meetings follow.

THE COMMAND FLIGHT PATH DISPLAY PROGRAM

Calspan, Buffalo, N.Y.

MAY 5 - 6, 1982

MAY 5

0930 - Introduction of participants and opening remarks.

0945 - Visit hangar to inspect TIFS aircraft.

1030 - Discuss the CFPD system and the components to be supplied by MILTOPE and DEC.

1130 - Lunch

1300 - Review Program Objectives, Management Responsibilities, and Procedures.

1330 - Discuss Software Specifications, INTERMETRICS Schedule, and CALSPAN Schedule.

INTERMETRICS and CALSPAN continue to develop software specifications.

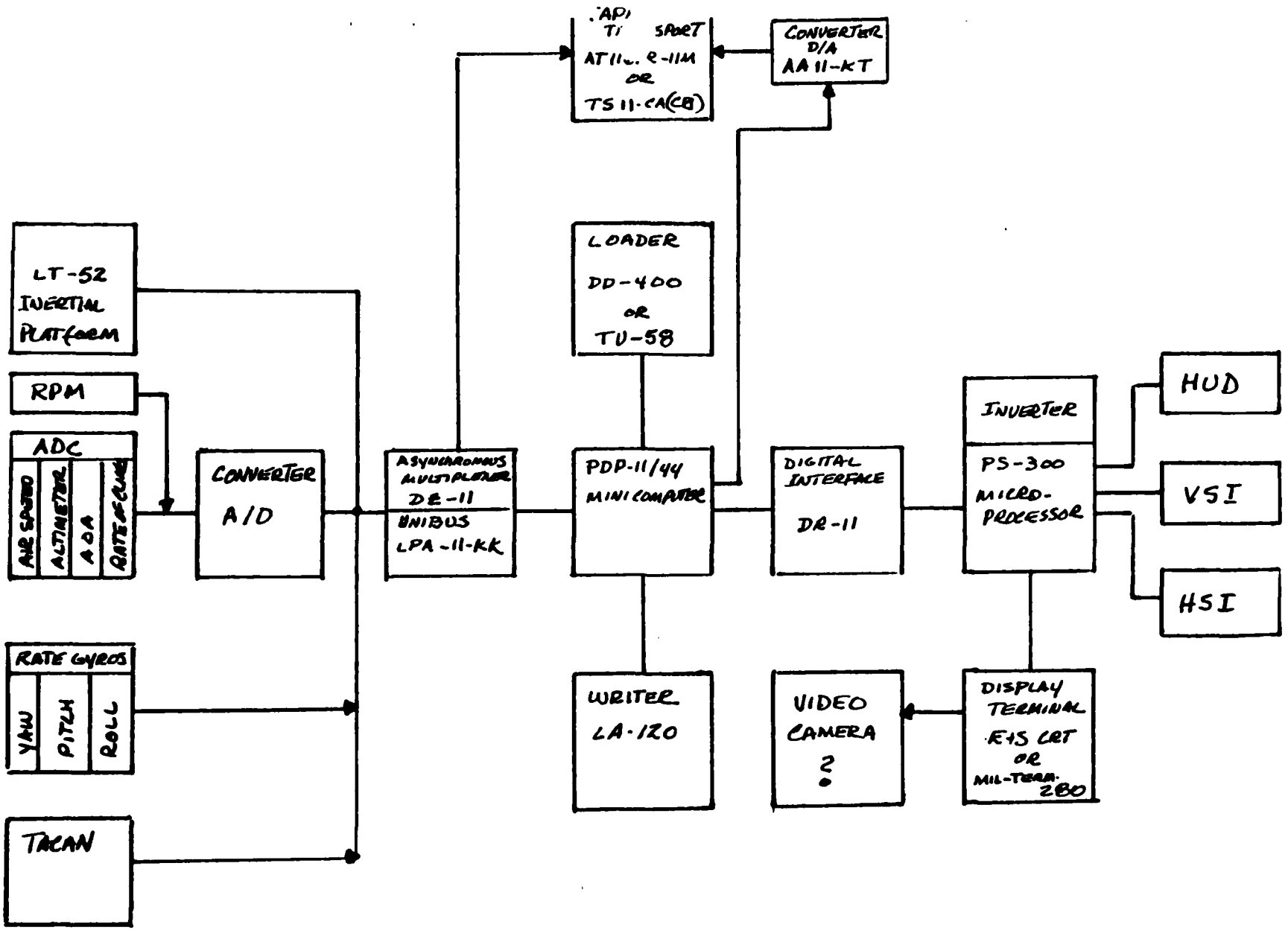
RMS and CALSPAN discuss contractual arrangements.

RMS and CALSPAN discuss installation and cockpit layout.

MAY 6

0930 - Open discussion followed by continued development of the software specification and INTERMETRICS Schedule and CALSPAN Schedule.

Establish time and place for next meeting of participants.



CFPD EQUIPMENT DIAGRAM #3

CFPD/TIFS KICKOFF MEETING

on May 5 and 6, 1982

1. Flight Hardware and/or Equipment Configuration

   a. Aircraft Sensor (Guidance) Requirements

      - INS
      - ILS
      - TACAN
      - Other A/C related flight parameters

   b. Peripherals and Tradeoffs (size, weight, performance, commercial vs military, etc.)

      - Digital Recording: CR-600 vs TIFS 58 channel recorder and D/A's vs DD-400
      - Program Load: TU-58 vs DD-400
      - Computer Terminal: TIFS HP2746A vs LA-120; hand copy requirement
      - PS-300 Terminal: E & S CRT vs MIL-TERM-280 vs TIFS HP2746A
      - Hard Copy ??
      - Battery Backup Unit

   c. PS-300 to HUD, HSI and VSI Interface Responsibilities

   d. Aircraft Sensor Interface Controller

      - A/D, INS, WAD, Discrete, D/A, TACAN
      - Separate I/O box to unibus cable for initial checkout - perhaps place in 11/44 if room available.

   e. Final Computer; I/O Controller and Peripheral Configuration

   f. Address Assignments, interrupts and DMA priorities to be assigned later.

   g. Schedules - Hardware delivery and location

2. Software Performance Specification
(A/C interface to main line program)

a. Aircraft Sensor Requirements
   - INS, ILS, TACAN, WAD, etc.

b. Sensor Processing Requirements and Data Interface to Main Line Software
   - Guidance Modes and Data
   - Mode Status Indicator
   - WAD Indicator
   - Update and Processing Rates

c. Automatic and Manual Mode Control Logic

d. Test Software

e. Input Data Requirements (e.g. flight profiles, runways, etc.)

f. Recording Requirements

g. Overall Processing Rates

CFPD EQUIPMENT LIST

1.	PDP-11/44CA(CB) Minicomputer	
	W/256Kb Memory	$29,300
	Operating System RSX-11MDR 11S	
	a. DD11-DK Backplane	940
	b. FP11-F Floating Point Processor	3,100
	c. KW11-K Realtime Clock	1,150
	d. DR11 — Digital Interface	
	DR11-C $ 640	
	DR11-B 2,150	
	DR11-W 1,650	
		2,150
	Total	$36,640
2.	TU-58-DA — Loader	
	Rack Mountable	$ 1,850
	or	
	DD-40D (MIL) — Loader	9,080
	RX11 (NORDEN)	?
	Mating Connector	400
	Terminator	200
	Enclosure	1,000
	Slides	250
		$10,930
3.	MIL-TERM-280 — Display Terminal	$15,600
	Mating Connector	225
	Slides	500
		$16,325

CFPD EQUIPMENT LIST (Continued)

4. AT1161R-11M – Tape Transport	$26,250
Mating Connectors	575
Slides	4,500
Terminator	325
Shock Block	600
	$32,250
or	
TS11-CA(CB)	
Rack Mountable	$14,800
5. LA120-DA Del Writer	$ 2,800
6. DE-11 Asychronous Interface	$2,700
7. LPA11-KK Unibus	$8,600
8. AA11-KT Converter (D/A)	$1,650
9. Video Camera	
Over-the-shoulder	?

Questions:

1. Which DR-11
2. What rack will be used on aircraft?
3. Will a different rack be required in the lab?
4. What pattery packs are available to backup memory loading?
5. Does loader have to be hard disk?

March 24, 1982

COMMAND FLIGHT PATH DISPLAY PROGRAM

CONCEPT DEFINITION

Although many reports and papers have been published since the inception of the Command Flight Path Display concept, there have been a wide variety of misinterpretations of the relative importance of the various elements of the integrated display format, as well as the adequacy of the information inherent in the display. These misconceptions have resulted in creating a number of variations in the display format, elimination of basic elements of the display, distortions of the display elements, and overlaying the basic display with alphanumerics and graphic symbols. In every evaluation study performed by several government and industry laboratories in which the basic format of the concept was changed, the effectiveness of the display was destroyed; not intentionally, but due to gross misunderstanding of the concept fundamentals. Perhaps the worst case in point was the A6A installation where the total concept was eliminated and reduced to arbitrary symbols.

In view of the above, it is essential that the overall CFPD concept be clarified because it is the only basic criterion which can be used to evaluate candidate flight test programs.

Command Flight Path Display Concept Definition

The Command Flight Path Display Concept is defined as a pictorial presentation of totally integrated real world visual cues which provides the pilot of an aircraft with the following information:

Orientation - Where am I and what am I doing?

Director - What should I do and when?

Quantitative - How am I doing?

All three categories of information are presented relative to the real world vertical plane on a cathode ray tube called the Vertical Situation Indicator

or VSI; and relative to the real world horizontal plane, on a cathode ray tube called the Horizontal Situation Indicator or HSI.

The Vertical Situation Display Format should be preferably displayed on a HUD(VSI) because this is one of the major requirements of the overall concept. It can also be displayed on a panel mounted CRT VSI. In both cases the display format consists of the following three independent elements:

1. A dynamic earth plane or "contact analogue" composed of external reference, linear perspective, texture, size, and motion parallax visual cues, with the capability of angular and linear displacement relative to all three axes.
2. A dynamic flight path composed of the same visual cues as the contact analogue and with the same six degrees of freedom.
3. A command velocity indicator displayed as a three dimensional aircraft located at the left side of the flight path with the capability of changing in size and perspective as the pilot alters his formation position.

The Horizontal Situation Display Format is always displayed on the HSI which should be oriented to the horizontal plane. The format consists of the following elements:

1. A topographical map or tactical plot depending upon the type of mission being conducted is provided covering the operational area of the aircraft including terrain characteristics, potential obstacles, navigational aids locations, operational bases, destinations, and targets.
2. A geographical Command Flight Path indicating the proposed or altered flight plan including all segments and way points, the aircraft shadow representing present position relative to the flight path, an indication of where the aircraft should be on the flight path, and an elipse which indicates range remaining relative to present power, altitude and velocity.

In the proposed program both displays will be included but emphasis will be placed on the Vertical Situation Display with the HSI providing only the geographical Command Flight Path and the aircraft position relative to the Command Position. The program objective is more directed to the ability of the pilot to fly the aircraft effectively under IFR conditions, particularly with respect to take off and landing, and normal flight operations rather than tactical missions, in the initial program phases. The above in brief, describes the overall basic Command Flight Path Concept. It must be stressed that all of the elements of the VSI display must be included because all of the elements are necessary to provide an integrated display and present the required information. Years of research have resulted in this unique display concept, and should not be ignored just to try another intuitive idea.

PROCEDURES

Because of the very tight project schedule, all meetings of the project participants will be planned and coordinated by RMS. If additional meetings are requested, RMS must be notified to arrange the meeting with minimal interference with the project schedule.

Records must be maintained of all communications among the participants which might have an impact on the project cost or time schedule. RMS must be notified as soon as possible if critical situations occur or are probable.

No publicity releases relative to the CFPD program are permitted by any of the participants until approved by NAVAIR. A publicity program is planned and will be initiated when approved by NAVAIR.

COMMAND FLIGHT PATH DISPLAY

MANAGEMENT RESPONSIBILITIES

RESOURCE MANAGEMENT SYSTEMS

Resource Management Systems will act as the project manager, and will be responsible for the following:

1. Definition of the overall project objectives and the requirements to meet these goals.
2. Definition of the Command Flight Path Display concept.
3. Functional design of the system to produce the CFPD.
4. Purchase or lease of all required major system components and maintenance support not available in the selected test aircraft.
5. Definition of the subcontract Statement of Work.
6. Negotiation of the subcontracts.
7. Establishment of the project milestones, coordination of the sub-contractors, and monitoring the project schedule.
8. Definition of the CFPD concept evaluation flight test objectives and the design and execution of a suitable flight test program.
9. Analysis of the flight test data.
10. Preparation of the necessary documentation covering the overall project and the test results.
11. Execute final modifications of the system to insure its adequacy for the Navy Flight Test Evaluation by NATC.

INTERMETRICS

Intermetrics under a subcontract issued by RMS will be responsible for the following:

1. Development of the algorithms for the generation of the CFPD on a PS-300.
2. Preparation of the software specifications for the PDP-11 and the PS-300.
3. Coordination of the PDP-11 and PS-300 software specifications with the Calspan sensor data software specifications and preparation of a total system software specification.
4. Definition of the sensor data input requirements for the PDP-11 computer.

INTERMETRICS (continued)

5. Development of the software for the PS-300.

6. Development of the software for the PDP-11 as it relates to the PS-300.

7. Software check out for the total system, jointly with Calspan.

8. Definition of the recording requirements for the concept evaluation flight test.

9. Reduction of the recorded data from the concept evaluation flight test.

10. Software support during flight test.

CALSPAN

Calspan will be responsible for the following:

1. Preparation of software specifications for sensor data conversion for PDP-11 inputs, working in conjunction with Intermetrics.

2. Establishment of sensors and software required to provide data inputs to the PDP-11.

3. Definition of system integration and installation requirements.

4. Design of the system installation.

5. Fabrication of the system interconnections.

6. Installation of the system.

7. Check out of the total system, via a complete end-to-end software check.

8. Provide Flight Test Operation support and obtain Air Force approach for flight test.

9. Provide Flight Test Aircraft and System maintenance support, except for RMS and Navy GFE.

10. Provide pilots for the concept evaluation flight test as requested by RMS.

11. Furnish quick look of flight recorded data after each flight.

12. Provide data tapes for subsequent analysis.

CFPD/TIFS KICKOFF MEETING

NAME	REPRESENT	TELEPHONE
B. J. Eulrich	Calspan	(716) 632-7500, Ext. 5255
S. Shelley	Intermetrics	(617) 661-1840
Bob Cook	RMS	(703) 920-5225
Al Carrato	RMS	(714) 268-8676
George Hoover	RMS	(213) 454-9608
Paul Slonaker	Intermetrics	(617) 661-1840
Jack Barry	Air Force Flight Dynamics Lab	(513) 255-6526 AV 785-6526
Clarence Mesiah	Calspan	(716) 632-7500, Ext.5258
James Dittenhauser	Calspan	(716) 632-7500, Ext.5280
Tom Gavin	Calspan	(716) 632-7500, Ext.6849
Rey Hylant	Digital	(716) 675-7230
Gary Stornelli	Digital	(716) 675-7230
Phil Reynolds	Calspan	(716) 631-6715
Arno Schelhorn	Calspan	(716) 631-6737
Bob Ahlgren	Calspan	(716) 632-7500
Steve Filarsky	NADC, Warminster, PA	(215) 441-2088
Fred Hoerner	NATC, Patuxent River, Md.	(301) 863-4157
Charles J. Berthe	Calspan	(716) 632-7500, Ext. 5277

TIFS CFPD STATUS REVIEW

9 June 1982

INTERMETRICS, INC., CAMBRIDGE, MA.

MEETING NOTES

I. Attendees - See Attachment I

II. Welcome to Intermetrics by J. Morin

III. Outstanding Action Items

1. Update of hardware block diagram
2. Correction of errors on hardware list
3. Question arose concerning TU-58 recorder on the A/C.
4. The PDP-11/44 rack will not go in the A/C. Chassis be ruggedized.
5. Al Carrato reviewed Xytron meeting
   - CRT's can be built to spec
   - Delivery 90-120 days @ approximately $6K/CRT
   - 9" diagonal selected
   - Air Force requires MILSPEC or FAA certification
   - Each driver weighs 50 pounds
   - Each scope weighs 25 pounds
   - Xytron will hang scopes on own PS-300 to set brilliance
   - Intensity knob can be put on each scope
   - Cable length between CRT and driver is fixed at 10 feet. Xytron sees no reason why the cable between driver and PS-300 cannot exceed 35 feet. Will allow positioning of PS-300 further aft in the A/C.
6. HUD - VSI - HSI
   - Hughes wide angle HUD would have to be modified if used.

12. Films

- Calspan - HUD
- George Hoover - Simulator Highway In The Sky

IV. Next Status Review

- July 15th and 16th, 1982, Calspan - Buffalo, NY

V. Software Specifications

1. Copies of the following distributed:
   A. Command Flight Path Display software functional specifications
   B. CFPD control structure dated 6/8/82
   C. CFPD S/W functional flow during run dated 6/8/82
   D. Status Report dated 9 June 1982
2. Software sensor dumps will be included in the specifications by the end of June
3. HUD standard symbology required
4. WAD requirements not defined
5. Flare and landing phases of flight are to be included
6. A closed loop flight path is required in CFPD software
7. A transition path to intercept the highway is desired. Restart is being considered along with other alternatives
8. Software specification updates will be provided at each monthly meeting
9. Calspan/Intermetrics interface datail to be resolved by the end of June

VI. Flight Plan

1. P. Reynolds will talk to Buffalo Approach and Niagara Tower to inform them of CFPD flight test parameters and requirements.

- Concern over scale difference visual to CRT during landing mode
- Discussion concerning use of virtual runway for landing checkout
- HUD availability still uncertain

7. The video camera and recorder to monitor the CRT will be compatible with Intermetrics' VHS system. No funds have been identified for additional cameras or calibrating and mixing units. Power requirements have to be given to J. Dittenhauser when identified.
8. Loss of power effect on software
   - Requirements for Intermetrics software download unknown
   - Interface is 56 K Baud maximum between PS-300 and PDP-11/44
   - Possibility of back up battery for PS-300 will be checked
9. TC-11 recorder cable length will stay at 15 feet unless Calspan requires change
10. Inertial Navigation Platform - LTN-51
    - Availability unknown
    - Use of other than LTN-51 will require software development @ approximately $10K and unknown time factor
    - Priority item is locating suitable platform
    - Calspan to provide part number list of LTN-51 to RMS and NADC
11. PS-300 memory capacity
    - Determination on the requirement for the second M byte will be made by S. Shelley upon completion of June 21st training session.

2. Gross weight limitations will prevent touchdown during first hour of flight

3. Flight plan discussed with take off from Buffalo, approaches to Niagara, final approach and landing at Buffalo

VII. Hardware Delivery

1. Updated - See Attachment 2

VIII. Evans & Sutherland Visit Review

1. Training review

A. Week of June 21st - Newport Beach, CA

Steve Shelley - Intermetrics

Walter Welch - RMS

B. Week of August 2nd - Hartford, CONN

J. Ryan, NADC

C. Mesiah, Calspan

B. Eulrich, Calspan

W. Welch, RMS

TBD, Intermetrics

IX. Aircraft Fabrication and Delivery

1. Rough of A/C layout shown

2. Copy to be sent to RMS by 6/13/82

3. Smooth layout in work

X. Safety Pilot Concerns/Actions

A partial list of topics discussed are as follows:

1. Maximum throttle

2. Single engine

3. Abrubt movement on take off

4. Use of direct lift flaps, side force surfaces

5. Rotation speed and over rotation

6. Weather minimums/flight objectives

7. Touchdown/drift

8. Uncertain responses and movements

9. Icing conditions

10. Turbulance

11. Right and left turnouts

XI. Action Items - See Attachment III

ATTACHMENT I

6/9/92

2ND MEETING CFPD/TIFS AT INTERMETRICS

1.	B. Eulrich	Calspan	
2.	P. Reynolds	Calspan	716/631-6715
3.	W. Welch	RMS	703/920-5225
4.	V. Cronauer	RMS	703/920-5225
5.	S. Shelley	Intermetrics	
6.	G. Hoover	RMS	213/454-9608
7.	A. Carrato	RMS	714/268-8626
8.	S. Filarsky	NADC, Warminster	215/441-2088
9.	P. Slonaker	Intermetrics	
10.	J. F. Morin	Intermetrics	617/661-1840

ATTACHMENT III

ACTION ITEMS FROM CFPD STATUS REVIEW MEETING

9 June 1982

at

INTERMETRICS, INC. - CAMBRIDGE, MA

CALSPAN

1. Verify for Steve Shelley that the TU58 recorder will be installed in the PDP-11/44 when delivered and will be available in the A/C for diagnostic purposes. (Jim Dittenhauser)

2. Determine requirements of a back-up battery for the PS-300. (Jim Dittenhauser)

3. Determine required length of cable to TC-11 controller. Currently it is planned for 15 feet and will stay at this length unless Calspan determines UNIBUS constraint requires a change. (Jim Dittenhauser)

4. Continue searching for LTN-51 inertial navigation platform or suitable replacement.

5. Provide RMS and NADC with detailed requirements of LTN-51 system. (Jim Dittenhauser)

6. Notify Buffalo Approach and Niagara Tower of CFPD in preparation for flight test. (Phil Reynolds)

7. Resolve software detail and interface by June 24. (Joint w/Intermetrics)

8. Provide RMS with list of safety pilot concerns/actions. (Phil Reynolds)

RMS

1. Provide Air Force with information on Xytron CRT's to satisfy FAA

certification requirements. (Vic Cronauer)

2. Provide Calspan with monthly budget through November. (Al Carrato)

3. Update contract to show CRT's ordered from Xytron. (Al Carrato)

4. Ensure camera and recorder are compatible with VHS system of Intermetrics. (Vic Cronauer)

5. Provide power requirements of camera and recorder to Jim Dittenhauser. (Vic Cronauer)

6. Hardware diagram update. (Al Carrato)

7. Search for available LTN-51 inertial navigation platform or suitable replacement. (Ray DeLeon)

8. Include software flow diagram in monthly progress report. (Al Carrato)

9. DEC maintenance contract $/HR to NADC and Calspan. (Vic Cronauer)

10. Determine when 56 K Baud interface is available. (Walter Welch)

INTERMETRICS

1. Determine requirement for second MB of memory required for PS-300 by 25 June. (Steve Shelley)

2. Complete software sensor dump spec by July 1. (Steve Shelley)

3. Resolve software detail and interface by June 24. (Joint w/Calspan)

4. Software specs to Al Carrato prior to July 19 meeting. (Steve Shelley)

NADC

1. Notify RMS by June 28 concerning use of Hughes wide angle HUD. (Steve Filarsky)

2. Notify RMS/Calspan by June 28 concerning availablilty of Furan HUD. (Steve Filarsky)

3. Continue search for available LTN-51 inertial navigation platform or suitable replacement. (Steve Filarsky)

4. Define HUD standard symbology and provide to Steve Shelley and Vic Cronauer. (Steve Filarsky)

5. Send letters of commitment to Evans & Sutherland and DEC to ensure equipment identification prior to purchase order arrival.

   (Steve Filarsky)

Copy To: B. Eulrich
P. Reynolds
W. Welch
S. Shelley
G. Hoover
A. Carrato
S. Filarsky
P. Slonaker
J. Morin
J. Dittenhauser

CFPD STATUS REVIEW MEETING

17 & 18 August 1982

ARVIN/CALSPAN, BUFFALO, NY

MEETING NOTES:

I. ATTENDEES - See Enclosure (1)

II. OUTSTANDING ACTION ITEMS FROM 9 JUNE 1982 REVIEW MEETING

1. Intermetrics has requested the TU-58 recorder remain in the PDP-11/44 when installed in the A/C. Calspan has indicated that arrangements will be made to keep the TU-58 recorder in the PDP-11/44 and make it available for diagnostic testing.

2. A back-up battery capability for the PS-300 is not feasible. The internal circuitry of the PS-300 is fixed and would require a major engineering effort to redesign the system. The time element involved, the cost, and the willingness of Evans & Sutherland to undertake the task are all factors that prevent a back-up battery capability for the CFPD project.

Loss or interruption of power to the PS-300 would result in a software crash and loss of the CFPD display. Calspan has indicted that loss of A/C power is a remote possibility and to their knowledge, has never occurred on the TIFS aircraft.

3. Calspan has prepared a request for procurement for a TS-131PE NRZI/PE (800/1600 BPI) Magtape system including:

a) TC-131PE Magtape Controller

b) Kennedy "9800" ruggedized, dual density (800BPI/1600BPI) 37½ inch per second, 9 track tape drive

c) Cables from controller to tape drive (10 foot length)

d) Diagnostics and documentation

e) Installation, including 90 days on-site service at Intermetrics, Cambridge, Massachusetts.

The request for procurement will be released upon receipt of Air Force approval which is expected by 18 August. An additional installation/on-site service item will be requested for support of the equipment at Calspan, Buffalo, NY when the equipment is delivered to Buffalo. The required date of delivery is 15 September. Western Pheripherals, Div. of WESPER Corporation is quoting 60 day delivery but has indicated that the equipment specified is currently "on the shelf" and could possibly be delivered in 30 days.

4. The Inertial Navigation System required for the project will be the LTN-72. NADC will acquire the LTN-72, pallet, and interconnects and will have it delivered to Calspan by September 15. The decision on the software change to provide one additional bit of resolution (to achieve ±20 ft; currently ±40ft) will be made after seeing the results of a complimentary filter in the PDP 11/44. The filter will provide a higher gain on velocity but will also result in higher succeptibility to noise. Should the software change be necessary, it will take 75 days at a cost of $13,490.

A discussion was held concerning INS error. A precision error of 2 miles per flight hour is possible with the INS. The Command Flight Path is preprogrammed and receives position sensor input from the INS. In the approach route the possibility exists that the Command Flight Path could fail to intercept the ILS signal because of the position error.

The programming of the Command Flight Path is in a hierarchic structure. The flight test can be broken down into routes/segments. The restart capability of the command flight path will allow us to have the safety pilot fly the aircraft to a known position (i.e. Vortac or ILS outer marker) in order to get a good initialization in the sensor software. The INS error will be corrected at that point and the approach route can be flown.

5. TIFS safety and operational information on the CFPD program were outlined in TIFS memo No. 1000 dated 30 July 1982, and supplemented in a letter to Mr. George W. Hoover from P.A. Reynolds dated 30 July 1982. Copies of the above were distributed.

6. Clarification of the requirements needed to satisfy the Air Force Class II Modification was requested. Calspan is responsible for providing both Part I and Part II of the Class II modification report to the Air Force for approval. RMS's concern was the possibility of continuing the project as is currently planned and to end up without Air Force approval for equipment installation. Mr. Jack Barry stated that there were two basic requirements;

A. That the equipment will not break or cause damage to the aircraft
B. That the equipment will not cause injury to anyone

Calspan has responsibility for the installation of the equipment and will insure that it meets the requirements. The two items that remain concerns are the flightworthiness of the Xytron CRT's and the PS-300.

Part I of the report will be completed by 27 August. Part II is planned to be completed by 1 December.

7. An update of costs to reflect current project planning through 1 February 83 are required by NADC.

8. A video camera, recorder and monitor were identified by RMS and power requirements were provided to Calspan. NADC has assumed responsibility for acquiring the equipment, mounts and cables and ensuring compatibility with VHS format.

9. Consensus was reached to not purchase the DEC maritime agreement. DEC maintenance response at Calspan has been within a day of the trouble call which is well within the 72 hour response time that the maritime agreement guarantees.

10. The 56 k baud interface consists of the DMR11-AE, the RS449 cable, and the high-speed DEC interface upgrade option (software).

11. The second MB of memory for the PS-300 is not needed. Intermetrics and Evans and Sutherland have discussed the possibility and feel one MB should be more than sufficient. A second MB if required is readily available for $18,000.

12. The software detail and interface between Calspan and Intermetrics was completed by the end of June.

13. The Hughes wide angle Hud will be used. NADC will contact NAVAIR to determine the schedule of the equipment and ensure its availability to meet program requirements.

14. F-18 symbology was selected as the standard symbology.

III. SOFTWARE SPECIFICATIONS

1. Steve Shelley provided updated CFPD Software Functional Specifications.

2. The Command Flight Path will be pre-determined with no inflight modifications to the loaded flight plan, with the exception of the selection of the intended runways. Flight Path "loops" will be supported which will allow operator control of exiting or continuing in the loop.

3. A given flight plan is considered to be a hierarchic structure consisting of the following elements:

Flight Plan

Routes

Segments

Plates

IV. HARDWARE DELIVERY

1. Enclosure (2) is a summary reflecting current hardware delivery dates. In addition, it indicates responsibility for ordering, original delivery destination, cost, and changes from original plans.

2. CFPD System Diagram #7 - see enclosure (3)

V. A/C FABRICATION AND INSTALLATION

1. Calspan provided a blackboard drawing showing tentative location of the various major hardware components. Removal of approximately 400 pounds of analog computer equipment will allow installation of the HUD and two head down displays w/drivers in the evaluation cockpit without disrupting weight and balance constraints. Two options are being considered for the inertial navigation package. It could be placed either on a tie down pad near the wing-fuselage juncture on the cabin floor or in the tail cone which would save ballast weight but require removal of control cables for installation. The LA-12D keyboard, VSI monitor, camera and recorder would be located near the present TIFS test engineer station. The digital computer cabinet at the rear of the cabin would be emptied and refilled with CFPD computing equipment. The 60 Hz converters will be in the tail cone area.

2. A normal crew of six is planned consisting of two safety pilots, one TIFS engineer, one CFPD engineer, one test pilot, and one observer.

3. Evaluation pilots will be selected by Mr. George Hoover, consultant to RMS. They must be approved by NADC, the Calspan Chief Test Pilot and the Air Force. Anyone in the aircraft must have a current FAA medical certificate III class.

4. Demodification costs for the TIFS aircraft have not been identified.

5. Interface with a possible Air Force simulation program (X-29A) was discussed. The X-29A at present is not committed but negotiations to utilize the TIFS aircraft from December 15, 1982, to January 15, 1983, are in progress. The interface with CFPD would result in the loss of installation and ground check out time, force a bench set up for check out, and add interim demodification costs. The commitment for documented flight test results by February 28, 1983, of the CFPD have not changed.

VI. FLIGHTPLAN

1. Mr. Hoover displayed line drawings and photographs of the CFPD database that were developed on the PS-300 by Evans and Sutherland.

2. The Air Force requires that the test plan be in their hands a minimum of 15 days prior to flight.

3. Flight plan preparation will begin the week of September 5 following installation of the PS-300 at Intermetrics. The plans will be developed in accordance with the safety and operational constraints provided by Calspan. The flight plans will be given to Calspan for review and modifications will be made as necessary. The initial flight plans will be prepared by September 28.

4. Calspan will prepare the test plan and submit it for Air Force approval.

VII. OPEN DISCUSSION ITEMS

1. HUD
   a) Mr. Hoover and Mr. Shelley have a meeting with Hughes August 24th to discuss integration with the PS-300.
   b) Availability dates of the HUD are not known at this time. Mr. Filarsky will contact NAVAIR and establish availability dates by 1 September. CFPD requirements are that it be available for a two week compatability test with the PS-300 prior to installation in the aircraft. It is required by January 1, 1983, at Calspan for installation. The wooden model and receiver are required as soon as possible at Calspan for cockpit layout and provision of conditioned air and input connectors.

2. PS-300

a) Mr. Shelley will visit Evans and Sutherland on 23 August for a demonstration of the special functions.

b) The standard PS-300 delivery date to Intermetrics is 30 August.

c) A proposal from Evans and Sutherland on ruggedization of the PS-300 is expected.

A telephone conversation with Mr. Bassett provided the following information. E&S will provide a PS-300 in a non-standard, unsupported, aluminum chassis with the current edge connectors for approximately $66,000, available 75 days after receipt of order. The edge connector kit will not be available until approximately 1 December. E&S will provide up to 5 days of engineering support to help in the retrofit of the connectors.

d) Negotiations concerning the retrofit will continue upon receipt of the proposal. Time constraints will require Calspan to issue the purchase order for the "ruggedized" PS-300.

3. CRT's

a) Calspan will issue purchase orders for the Xytron CRT's upon receipt of Air Force approval.

b) Provided detailed drawings of the displays are made available to Calspan for installation preparation, actual delivery of the CRT's in December will not delay the flight testing.

c) A 9 inch diagonal display is preferred.

4. The LPA11-K and associated hardware from DEC arrived at Calspan July 23 and was interfaced to Calspan's PDP-11/45 computer. The series 4.0 upgrade software for the PDP-11/45 was received during the first week of August to upgrade the RSX-11M operating system.

5. One 60 Hz frequency converter has arrived at Calspan. The second is on order.

6. A request was made by Mr. Barry for improved communications within the project participants. He requested the Air Force receive copies of all project reports and be informed of events as they develop.

7. Shipping of CFPD equipment after initial delivery was discussed. Mr. Filarsky will investigate the possibility of Government Bill of Lading and provide direction as to the method that will be used.

VIII. NEXT STATUS REVIEW

1. September 28, 1982
   Intermetrics, Inc.
   Cambridge, Massachusetts
   0830

IX. NEW ACTION ITEMS

1. Identify demodification costs and provide to NADC (Calspan)
2. Obtain LTN-72, pallet, and interconnects by September 15 (NADC)
3. Provide NADC with LTN-72 cable lengths (Calspan)
4. Determine PS-300 - Hughes HUD interface requirements (RMS)
5. Prepare & submit Class II modification package to the Air Force (Calspan)
6. Provide information relative to the flight plans to Calspan (RMS)
7. Contact NAVAIR and determine specific HUD availability dates by 1 September (NADC)
8. Provide HUD model to Calspan for installation preparation (NADC)
9. Provide equipment shipping method for CFPD participants (NADC)
10. Provide NADC with cost update on labor and equipment (Calspan/RMS)
11. Issue purchase orders for TS-131 PE magtape system, Xytron CRT's, and "ruggedized" PS-300 (Calspan)
12. Issue purchase orders for video, camera, recorder, monitor, cables, and mounts (NADC)
13. Provide video tapes and magnetic tapes for recording (NADC)
14. "Continue to March" - February flight test (all participants).

17 August 1982 CFPD Program Review Meeting Calspan Corporation

VISITOR REGISTRATION

Jack Barry	AFWAL/FIGD	513-255-4690
Cpt Mike Maroney	WPAFB, OH 45413	or AV 785-4618
Jim Dittenhauser	Calspan Corporation	716/632-7500 X5280
Stephen Shelley	Intermetrics Inc.	617/661-1840
Vic Cronauer	RMS	703/920-5225
George Hoover	RMS	213/454-9608
Phil Reynolds	Calspan	716/631-6715
Bernard Eulrich	Calspan	716/632-7500 X3255
Arno Schelhorn	Calspan	716/631-6737
Stephen M. Filarsky	NAVAIRDEVCEN	215/441-2088/2029
Bob Harper	Calspan	716/631-6836

Enclosure (1)

CFPD STATUS REVIEW MEETING

28 SEPTEMBER 1982

INTERMETRICS, INC.

CAMBRIDGE, MASS 02138

MEETING NOTES:

I. Attendees - See Enclosure (1)

II. PS-300 Display of CFPD

1. Mr. Shelley demonstrated a straight route dynamic test case of the Command Flight Path Display. The test case was developed by Evans and Sutherland to verify the image capability of the PS-300.

2. The standard F-18 symbology for the VSI and HSI were also shown on the PS-300 display.

III. Software Status

1. Delivery and set up of the PS-300 at Intermetrics was two weeks late. As a result Intermetrics software development has slipped approximately one week.

2. Mr. Shelley distributed a copy of the Intermetrics' CFPD Software Plan (Enclosure 2).

3. The critical portion of the software plan is the last week of October. The second DMR11-AE must be available by that time in order to meet the plan.

4. Calspan sensor software coding is approximately two weeks behind schedule. Delivery of the coding to Intermetrics will be by 15 Oct 1982.

5. Mr. Eulrich discussed Calspan logic and data base with Mr. Slonaker and Mr. Akiyama.

6. Calspan is receiving a patch to update the series 4.0 RSX-11M operating system.

7. Delivery of the synchro-to-digital converter and the multiplex modules has slipped to the end of November 1982.

8. The I/O interface chasis will be fabricated by 8 October 1982. Check-out will follow during the week of 11 October 1982.

9. A simulation tape of sensor data will be made by Intermetrics. The tape will be used to provide sensor data from the Kennedy recorder to the PDP-11/44 for CFPD software checkout.

IV. Flight Plan/Flight Test

1. Mr. Hoover distributed a CFPD flight plan based on the operational and safety requirements of Calspan (Enclosure 3). The basic flight plan with minor modifications will be used for the twenty hours of flight test.

2. Discussions on the flight plan included:

   a) Ground checkout and all flights will be recorded.

   b) Selection of pilots - sponsor, medical, and waiver requirements.

   c) Use of HUD or VSI - not both installed at same time.

   d) The flight path pattern will be modified to less than thirty minutes to allow one pattern/tape and three tapes/flight.

   e) Rate of climb - 500 feet per minute.

   f) Transition from VFR to IFR to VFR.

   g) Cockpit masked for CFPD - not for HUD.

   h) Touchdown on CFPD will not be demonstrated until last flight.

   i) Gear doors will not be removed as stated in the Class II Modification Report.

   j) Provisions for the WAD will be made. Actual use of the WAD is not anticipated during Phase II.

   k) TIFS cockpit location of the VSI is desired flush with the top of the instrument panel. The HSI should be tilted if possible without interfering with rudder pedal travel.

3. Mr. Hoover will prepare a tentative briefing guide which will break down the twenty hours of flight test into individual flights, pilots assigned, and sequence of events to be completed.

V. Outstanding Action Items

1. TIFS demodification costs have been identified by Calspan in the CFPD Class II Modification Part I.

2. A purchase order for the LTN-72 pallet and interconnects has been prepared by NADC. Status of the purchase order at NADC is not known. Calspan requests delivery of items by 8 October 1982. The LTN-72 identified for use on the CFPD program was delivered to Litton on 1 September 1982 for refurbishment. The refurbishment time was estimated to be one to two weeks. Mr. Filarsky will contact Litton

to determine delivery date of the unit to Calspan and will notify program participants.

3. The LTN-72 cable lengths are 35 feet.

4. PS-300 - Hughes HUD Interface. Mr. Hoover met twice with Hughes concerning the interface. Mr. Moor of Hughes is handling the HUD. The PS-300 line generator will have to be run at half speed. An adjustment to the unblank signal will be required for interfacing.

5. The Class II Modification Part I was prepared by Calspan and published in TIFS Memo No. 1008 dated 24 September 1982.

6. The flight plan is shown in Enclosure (3). Modifications will be made and a briefing guide prepared for the flight test.

7. Availability date of the HUD is dependent upon an as yet unscheduled avionics demonstration at MAC AIR. If the demonstration is in December 1982, the HUD will go to Intermetrics in November for check-out with the PS-300, to MAC AIR for the demonstration, and then to Calspan for installation. If the demonstration is in November, it will go to MAC AIR, Intermetrics and then Calspan.

8. The HUD model has not been shipped to Calspan. NADC will provide a specific date by 15 October 1982.

9. Equipment shipped after initial delivery will be repacked by vendor personnel and shipped by Government Bill of Lading arranged by NADC.

10. Calspan and RMS have provided NADC with updated cost figures. The second DMR-11-AE requirement has been identified since the update. The Air Force is requesting that NADC transfer a total of $174k by 14 Oct 1982. This increment will fund the program through 1 Dec 1982. An additional transfer of $582k will cover the last month of Phase I and the two months of Phase II.

11. Purchase orders for the TS-131 PE Magtape System, Xytron CRT's, and "ruggedized" PS-300 have been issued by Calspan.

12. NADC has a Coho camera and a monitor in-house. Delivery will be made to Calspan by 22 Oct 1982. A purchase order for the video recorder is in process at NADC. CNO approval is required before purchase order can be issued. The system is 3/4" - not VHS. Tapes will be converted to VHS format by NADC if required.

13. NADC will provide 40 video tapes and 20 magnetic tapes for recording purposes. The video tapes run thirty-minutes.

VI. Open Discussion

1. Mr. Hoover requested that he receive a copy of all Calspan reports sent to RMS.

2. RMS has not received a formal contract from Calspan or payment on the July invoice as of 28 September 1982.

3. The mounting bracket for the Hughes HUD will be delivered with the tray. The connector will be provided by NADC.

4. The 60 HZ frequency converter has been delivered to Calspan.

5. Plans to schedule the X-29A simulation program on the TIFS aircraft from 15 December 1982 to 15 January 1983 are continuing. Calspan stated the X-29A will be worked in on a noninterference basis. Ground checkout of the CFPD will take place partly on the bench using actual airborne equipment and cabling. The evaluation cockpit will be configured for CFPD on the left side and X-29A on the right side.

6. The cost of Calspan leasing a VT-100 CRT terminal and an LA-120 keyboard/line printer for use with their PDP-11/35 will be offset by a reduction in labor hours.

7. Calspan will contact DEC and attempt to shorten delivery time on the second DMR11-AE.

8. Mr. Hoover will contact Evans and Sutherland to arrange a visit to Salt Lake City for himself and Mr. Dittenhauser. The purpose of the meeting is to observe fabrication of the ruggedized PS-300, obtain information concerning the connector retrofit kit, and possibly provide information to Evans and Sutherland that will make the retrofit task easier.

9. Mr. Hoover will contact Hughes and arrange a meeting for himself and Mr. Dittenhauser to discuss details of the HUD - PS-300 interface.

VII. Next Review Meeting

1. The next CFPD Review Meeting is tentatively scheduled for the end of October in Washington, D.C. Details will be published when available.

VIII. Action Items

1. Sensor software delivery to Intermetrics by 15 Oct 1982. (Calspan)

2. Prepare briefing guide for flight test. (RMS)

3. Provide NADC with list of non-Calspan personnel who will fly in TIFS aircraft during test flights. (RMS)

4. Provide letter of sponsorship to the Air Force with names of all non-Calspan personnel who will fly in TIFS aircraft during test flights. (NADC)

5. Arrange meetings with Evans and Sutherland and Hughes. (RMS)

6. Contact DEC concerning delivery of the second DMR11-AE. (Calspan)

7. Contact Litton and determine delivery date of LTN-72. (NADC)

8. Ensure delivery of LTN-72 pallet and interconnects to Calspan by 8 Oct 1982. (NADC)

9. Provide HUD model to Calspan for installation preparation. Provide specific date for delivery by 15 Oct 1982. (NADC)

10. Issue purchase order for video recorder. (NADC)

11. Deliver video camera and monitor to Calspan by 22 Oct 1982. (NADC)

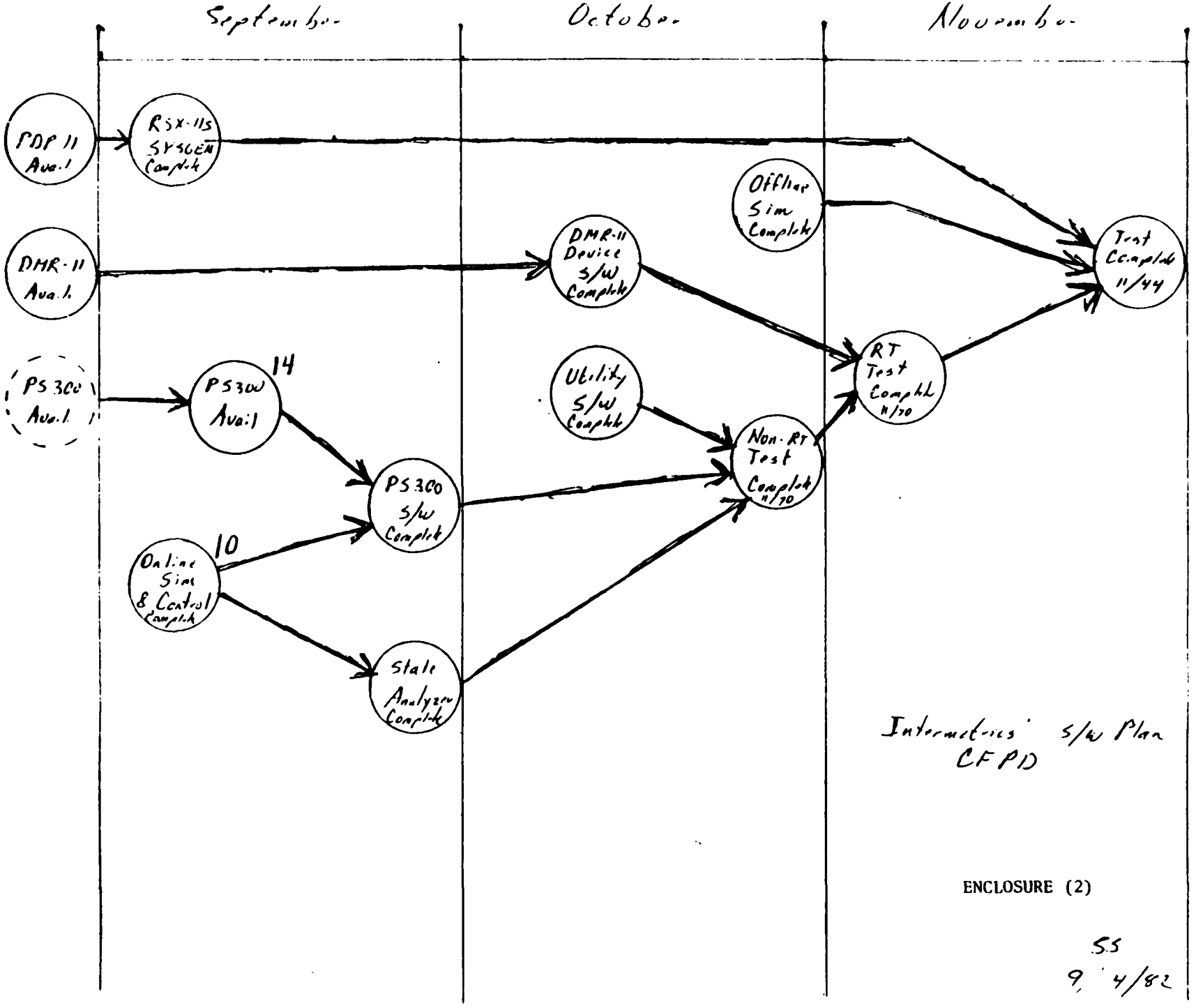
12. Provide 40 video and 20 magnetic tapes for recording purposes. (NADC)

CFPD STATUS REVIEW

28 September 1982

NAME	OFFICE	PHONE
Stephen Shelley	Intermetrics	(617)661-1840
George Hoover	RMS	(213)454-9608
Vic Cronauer	RMS	(703)920-5225
Neil Akiyama	Intermetrics	(617)661-1840
Larry Landreman	ASD/PMRNB	(513)255-2464
Jack Barry	AFWAL/FIGD	(513)255-3853
Phil Reynolds	Calspan	(716)631-6715
Capt. Mike Maroney	AFWAL/FIGD	(513)255-4690
Bernard Eulrich	Calspan	(716)632-7500 ext. 5255
Paul Slonaker	Intermetrics	(617)661-1840
Stephen Filarski	NADC	(215)441-2088
Hal Green	NADC	(215)441-2029

ENCLOSURE (1)



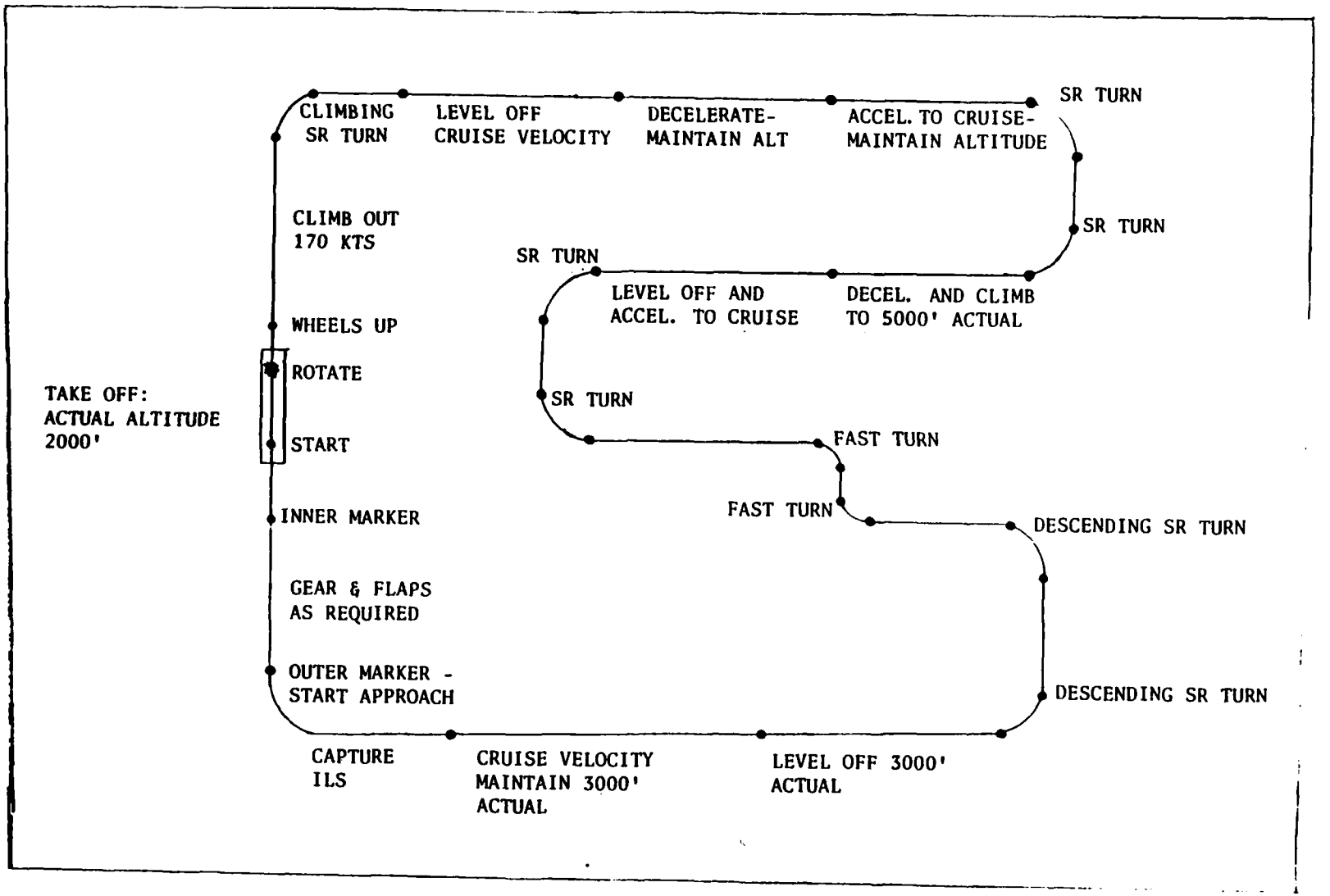
C-43

Intermediate S/W Plan
CFPD

ENCLOSURE (2)

55

9/4/82



CFPD FLIGHTPLAN

VIRTUAL AIRSPACE

ENCLOSURE (3)

CFPD STATUS REVIEW MEETING

28 October 1982

Arvin/Calspan, Buffalo, N.Y.

MEETING NOTES:

I. Attendees - See Enclosure (1)

II. Review of program objectives - See Enclosure (2)

III. Outstanding action items:

1. Sensor software delivery to Intermetrics by 15 Oct 1982 (Calspan).

- Mr. Eulrich and Mr. Mesiah delivered the initial sensor software to Intermetrics on 21 Oct 1982. No problems were encountered in integrating the sensor software with Intermetrics' software. Calspan expects sensor software to be fully complete by 5 Nov 1982.

2. Prepare briefing guide for flight test (RMS).

- A tentative briefing guide was prepared and distributed by Mr. Hoover.

3. Provide NADC with list of non-Calspan personnel who will fly in the TIFS aircraft during test flights (RMS).

- The list will be prepared and submitted as soon as medical requirements are completed.

4. Provide a letter of sponsorship to the Air Force with names of all non-Calspan personnel who will fly in the TIFS aircraft during test flights (NADC).

- NADC will notify Calspan of the personnel upon receipt of names from RMS.

5. Arrange meetings with Evans & Sutherland and Hughes (RMS).

a) A meeting was conducted at Evans and Sutherland, Salt Lake City, Utah on 21 Oct 1982. Mr. Hoover (RMS) met with Dr. D. Evans (E&S). Dr. Evans expressed his interest in providing support to the CFPD program. Mr. Hoover then joined Mr. Dittenhauser (Calspan), Mr. Martzolf (Calspan), Mr. Garner (E&S), Mr. O'Farrell (E&S), and Mr. Bassett (E&S) in discussions concerning the second PS-300. It was agreed upon that E&S would provide a standard unit within ten days of receipt of a modification to the current purchase order. The unit will be prepared for installation of the special back plane required for the new edge connectors. In addition, E&S will perform installation of the retrofit kit at Calspan on 1 Dec 1982. The unit will be covered by warranty until modifications are performed or the unit is placed in the TIFS aricraft. This agreement will result in delivery of a supported unit approximately four weeks

prior to the expected delivery date of the modular test frame configuration previously planned, eliminate the requirement for Calspan to incorporate the retrofit kit, and allow additional time for installation preparation.

b) A meeting was conducted at Hughes Radar Systems Group, Los Angeles, California on 22 Oct 1982 to discuss PS-300 - HUD interface. In attendance were Mr. Hoover (RMS), Mr. Dittenhauser (Calspan), Mr. Moor (Hughes), and Mr. Weihrauch (Hughes). Mr. Dittenhauser received answers to his questions concerning the interface and will take the actions necessary for preparation.

6. Contact DEC concerning delivery of the second DMR11-AE (Calspan).

- DEC has been contacted but has not provided a delivery date. Calspan has requested a cancellation cost should the delivery date be unacceptable and has prepared a purchase order to acquire one from E&S, should it be necessary.

7. Contact Litton and determine delivery date of the LTN-72 (NADC).

- The LTN-72 was delivered to Calspan on 3 Oct 1982.

8. Ensure delivery of LTN-72 pallet and interconnects to Calspan by 8 Oct 1982 (NADC).

- The pallet and interconnects have been delivered and the unit has been powered up. Pallet modifications required have been approved by NADC. Calspan will tag the pallet listing the modifications.

9. Provide HUD model to Calspan for installation preparation (NADC).

- The HUD model was delivered to Calspan on 21 Oct 1982.

10. Issue purchase order for video recorder (NADC).

- The purchase order for the video recorder is still awaiting CNO approval. NADC will check progress.

11. Deliver video camera and monitor to Calspan by 22 Oct 1982 (NADC).

- The video camera and monitor were delivered to Calspan on 28 Oct 1982. They will be returned to NADC upon completion of the program.

12. Provide 40 video and 20 magnetic tapes for recording purposes (NADC).

- A purchase order has been released for 30 magnetic tapes. The video tapes are on the same purchase order as the video recorder.

IV. Software Status Report

1. Intermetrics

a) Mr. Shelley distributed a copy of Intermetric's plan based on

actual hardware delivery (Enclosure (3)). He emphasized that based on experience, actual delivery of hardware does not mean up and running.

b) The high speed interface is not working. DEC and E&S are both working to determine the reason.

c) The custom firmware was received on 22 Oct 1982. Checkout cannot be accomplished until the high speed interface is working. E&S will send a new release version with micro code on 4 Nov 1982.

d) Development of the RSX-11S Sysgen has been delayed because of the high speed interface problem. All tasks that can be done without the high speed interface have been completed.

e) Intermetrics has requested use of the PDP-11/44 for real time testing for as long as possible. Calspan will determine the latest date acceptable to them for delivery of the unit.

2. Calspan

Initial delivery of sensor software was accomplished. Calspan will continue checkout of software and will provide Intermetrics with updated tapes as required. Full checkout will not be accomplished until it is integrated with the I/O chasis, which is expected by 15 Nov 1982.

V. A/C Fabrication and Installation

1. The majority of the design work is completed.

2. A new location is required for the PS-300 as a result of the change to a standard unit. The new location will be slightly forward of the original location. It will be strapped to tie downs on the cabin floor.

3. Stress analysis of the plastic case was accomplished by Calspan and the results meet with their approval.

4. Calspan has received verbal approval from the Air Force on the Class II Modification Part I. Capt. Maroney indicated that the holidays will most likely affect the length of time required for Part II approval and urged Calspan to submit it as soon as possible.

5. Mounting of the LTN-72 was easier than anticipated.

6. The CRT drivers will be mounted forward of the instrument panel on a platform that was approved on a previous modification.

7. The VSI will be mounted on the HUD tray using an adaptor. The location will be slightly higher than a normal VSI location. This mounting arrangement is required to eliminate interference with the HSI and allow the HSI to be flat or slightly tilted with the instrument panel.

8. There are 17° of position angle freedom for positioning of the HUD. The pivot will be determined based on pilot eye point and desired seat height.

VI. Flight Plan

1. A tentative flight plan was presented by Mr. Hoover (Enclosure (4)). The flight plan was prepared based on the following criteria:

   a) The program objectives

   b) Total flight time available

   c) Maximum time for a single flight

   d) Maximum tape recording time

   e) Evaluation of F-18 symbology relative to the CFPD

   f) Evaluation of both displays on CRTs under simulated zero-zero conditions and on the Hughes AIDS HUD.

   g) Actual coupled ILS approaches under simulated zero-zero conditions on the VSI and with the AIDS HUD.

   h) Time to reach the flight test area and time to return to base

   i) Indoctrination of the evaluation pilots

   j) Calspan safety requirements.

2. The flight test plan schedule includes ground simulation time for each pilot prior to actual flight.

VII. Milestone Update - See Enclosure (5)

VIII. Open Discussion

1. Calspan will do a vibration table test on all CFPD equipment, simulating expected TIFS environment conditions prior to submission of Class II Modification Part II.

2. Calspan will submit a purchase order to E&S for one person to attend the three-week PS-300 maintenance course.

3. A host computer and display are required for acceptance check of the second PS-300 at Calspan.

4. The high speed interface upgrade option is a one per processor item and will have to be purchased for the second unit according to E&S.

5. Early delivery of the second PS-300 to Calspan will allow HUD-PS-300 interface to be checked at Calspan, vice Intermetrics. NADC will arrange for HUD shipment to Calspan.

6. HUD interface will require the following:

   a) A voltage divider to reduce input signal

   b) A hardware change to place an additional port to accomodate the unblank signal

c) A delay adjustment to the PS-300

d) Connector pin modification or location of an alternate connector.

8. NADC is preparing contract agreements with DEC and E&S for support and maintenance.

9. The magtape recorder and controller was delivered to Intermetrics on 5 Oct 1982. Installation is planned for 1 Nov 1982.

10. The Air Force X-29A simulation project does not want to test in January as previously planned.

11. Calspan would like to have the PDP-11/44 operational in the lab prior to hardening. Estimated hardening time is one week. Calspan will notify Intermetrics of the latest acceptable date for delivery of the unit.

12. Calspan will notify Intermetrics of TIFS performance parameters.

IX. New Action Items

1. Prepare Class III Modification Part II for submittal to the Air Force (Calspan).

2. Prepare service agreements with hardware vendors (NADC).

3. Prepare purchase order for PS-300 maintenance course (Calspan).

4. Modify purchase order for second PS-300 by 29 Oct 1982 (Calspan).

5. Prepare PS-300-HUD interface (Calspan).

6. Provide second DMR 11-AE to Intermetrics by 8 Nov 1982 (Calspan).

7. Modify LTN-72 pallet as required and document modifications (Calspan).

8. Issue purchase order for video recorder and video tapes (NADC).

9. Provide NADC with a list of non-Calspan personnel who will fly in the TIFS aircraft during the test flights (RMS).

10. Approve and notify Calspan concerning personnel who will fly in the TIFS aircraft during the test flights (NADC).

11. Notify Intermetrics regarding PDP-11/44 schedule requirements (Calspan).

12. Notify the Air Force concerning VIP scheduling (NADC).

13. Provide Intermetrics with TIFS performance parameters (Calspan).

14. Notify RMS of any changes in equipment status (All Participants).

15. Provide Calspan with PS-300 installation guide (Intermetrics).

X. Next Status Review

1. RMS will publish notification of the next status review.

VTC

ATTENDEES

CFPD STATUS REVIEW MEETING

28 October 1982

Arvin/Calspan, Buffalo, N.Y.

Vic Cronauer	RMS	(703) 920-5225
George Hoover	RMS	(213) 454-9608
Phil Reynolds	Calspan	(716) 631-6715
Hal Green	NADC	(215) 441-2029
Stephen M. Filarsky	NADC	(215) 441-2088
Jim Uphaus	AFWAL/FIGR-WPAFB	(513) 255-6931
Stephen Shelley	Intermetrics	(617) 661-1840
Bernard Eulrich	Calspan	(716) 632-7500
Bruce McCoy	Intermetrics	(617) 661-1840 Ext. 5255
Mike Maroney	AFWAL/FIGD-WPAFB	(513) 255-3853
Clarence Mesiah	Calspan	(716) 632-7500
Jim Dittenhauser	Calspan	(716) 632-7500/5200

CFPD STATUS REVIEW MEETING

15 December 1982

Arvin/Calspan, Buffalo, N.Y.

MEETING NOTES:

I. Attendees - See Enclosure (1).

II. Outstanding Action Items:

1. Prepare Class II Modification Part II for submittal to the Air Force (Calspan).

-Calspan will not have a complete package for submittal until the vibration test is completed on 12 Jan 1983. An incomplete package will be submitted with the remaining installation of equipment documented by photographs and sketches.

2. Prepare service agreements with hardware vendors (NADC).

-Mr. Green has prepared purchase orders for service contracts with DEC, E&S, and Litton. He is investigating service agreements that will provide higher priority.

3. Prepare purchase order for PS-300 maintenance course (Calspan).

-No purchase order will be issued. The next scheduled course is in March 83.

4. Modify purchase order for second PS-300 by 29 Oct 82 (Calspan).

-Completed

5. Prepare PS-300-HUD interface (Calspan).

-Completed - See TIFS TM No. 1019.

6. Provide second DMR 11-AE to Intermetrics by 8 Nov 82 (Calspan).

-Delivered to Intermetrics on 16 Nov 82.

7. Modify LTN-72 pallet as required and document modifications (Calspan).

-Completed.

8. Issue purchase order for video recorder and video tapes (NADC).

-The video tapes have been delivered to Calspan. The recorder delivery to NADC has been delayed. Upon receipt at NADC it will have an acceptance check and then be shipped to Calspan.

9. Provide NADC with a list of non-Calspan personnel who will fly in the TIFS aircraft during the test flights (RMS).

-Completed - Memo sent on 29 Nov 82.

10. Approve and notify Calspan concerning personnel who will fly in the TIFS aircraft during the test flights (NADC).

-Completed - The Navy pilot not previously identified is LCDR J. Walters. LCDR M. Duncan will be the standby pilot.

11. Notify Intermetrics regarding PDP-11/44 schedule requirements (Calspan).

-Completed - The PDP-11/44 arrived at Calspan on 15 Dec 82.

12. Notify the Air Force concerning VIP scheduling (NADC).

-Will be completed once the schedule is established.

13. Provide Intermetrics with TIFS performance parameters (Calspan).

-Completed - The only change made to the flight plan is that the first deceleration will be to 150 knots vice 130 knots.

14. Notify RMS of any changes in equipment status (All Participants).

-Will continue until the end of Phase II.

15. Provide Calspan with PS-300 installation guide (Intermetrics).

-Completed.

III. Software Status Report

1. The LPA-11K checkout at Calspan has uncovered what appears to be a bug in DEC's microcode. One diagnostic will not run. DEC will not investigate the problem without a contract because the RSX-11M operating system on the PDP-11/45 is not under warranty. DEC suggested submission of a software problem report but response time on it would not help us. Mr. Eulrich indicated that patches can be made to get around the problem.

2. The electronics with the I/O are fully satisfactory.

3. Input timing will start on 16 Dec to determine the rate at which the PDP 11/44 will receive sensor data from the LPA-11K.

4. Provisions will be made for WAD information on the CFPD.

5. The CFPD application software is up and running at Intermetrics.

6. The limiting factor on timing appears to be how fast the PS-300 is prepared to accept data. Timing from buffer to buffer is 40 milliseconds for CFPD and 57 milliseconds for symbology.

7. Mode switching appears to add 10 milliseconds.

8. Overall software loading time is five minutes. Includes running the PS-300, loading the boot tape and loading the recording tape.

9. Intermetrics has found a resolution problem in the PS-300 that could be a microcode problem. K. Evans is checking into it.

10. Generation of an integrated software task tape at Intermetrics could be completed within five days of receipt of Calspan's final sensor software.

IV. A/C Fabrication and Installation

1. Two Xytron drivers have been fitted forward of the instrument panel.

2. One Xytron display has been mounted (HSI).

3. The HUD tray was installed for fitting.

4. The adaptor tray for the VSI has been built.

5. Hardware for the repeater VSI is being worked on.

6. The repeater driver will be in the cabinet below the display.

7. The recorder location is planned for the top of the cabinet.

8. A mounting base for the camera has been planned.

9. A rough sketch of the PS-300 mounting has been prepared. It's planned to mount a metal platform securely to the floor and shock mount the PS-300 in the platform. The floppy disc and power switch will be relocated to allow access on the same side as the circuit cards. In addition, the cabinet will be hardened to prevent as much movement as possible.

10. Installation planning for the PDP-11/44, I/O chasis, LA-12 D, and Kennedy recorder will start as soon as the items arrive at the hangar.

11. Wiring for the 60 Hz power converters is nearly complete. The converters will become a permanent part of the TIFS aircraft. Check-out is planned for the week of 19 Dec 82.

12. The Calspan-built cables are nearly complete.

13. All ICS and radio transmissions will be taped during the flight test.

14. A systems exercise flight is planned for 3 Jan 83. Installation of CFPD equipment will begin on 4 Jan 83.

15. NADC will check into the status of the HUD adaptor plug and bracket.

16. Air Force approval of the Class II Modification Part II is expected to take three weeks provided no problems arise. Calspan expects to submit it during the first week of January. Data on the vibration test is not required. A list of equipment and a statement that the equipment passed the vibration test will suffice.

V. Flight Plan

1. The flight plan configuration was flown on the 12 Nov TIFS system exercise flight. The only problem encountered with the flight plan was in reaching 130 knots during the first deceleration. To avoid a TIFS configuration change the airspeed will be changed to 150 knots.

2. Test plan submittal by Calspan to the Air Force is required 15 working days prior to the first flight.

3. Intermetrics will investigate the possibility of rotating the CFPD orientation while in the air to avoid having to load different flight plans.

4. Intermetrics will work out tacan way points to an even DME and then provide Calspan with a current description of flight plan data.

VI. Milestone Update - See enclsoure (2)

VII. Open Discussion

1. Mr. Cronauer stated SAI/RMS' concern about operating at risk without a contract in place. The current contract expires 24 Dec 82. Mr. Barry stated that the contract to Calspan was in place. Mr. Reynolds stated that it was in the final stages of procurement and the contract to SAI/RMS would be effective the same day as Calspan's. Mr. Barry and Mr. Reynolds would contact the Air Force contracting people and notify RMS of the status as soon as possible.

2. A memo to SAI/RMS increasing their cost ceiling to $262K is being prepared at Calspan. This increment covers costs through 30 Nov.

3. NADC passed $200K to the Air Force at the meeting. This increment brings the total to $1,141K.

4. Calspan distributed TIFS TM No. 1023; Subject: Amendment 2 - TIFS Task Plan for Flight Evaluation of the Command Flight Path Display (CFPD). The total estimated cost has increased by $7K due to higher Air Force costs.

5. Calspan's planned schedule for 15 Dec through 4 Feb is as shown in Enclosure (3). RMS and Intermetrics intend to conduct ground simulation and testing on 27 Jan 1983.

VIII. Outstanding Action Items

1. Prepare Class II Modification Part II and submit to the Air Force (Calspan).

2. Prepare TIFS test plan and submit to the Air Force (Calspan).

3. Investigate HUD schedule after 7 March (NADC).

4. Investigate service contracts that will provide higher priority (NADC).

5. Follow-up on Xytron's offer to provide delay card (Calspan).

6. Determine timing associated with sensor inputs to the PDP-11/44 (Calspan).

7. Provide Intermetrics with final sensor software (Calspan).

8. Provide integrated software task tape for ground simulation (Intermetrics).

9. Locate HUD adaptor plug and bracket (NADC).

10. Provide Calspan with current description of flight plan data (Intermetrics).

IX. Next Review Meeting

1. Arvin/Calspan, Buffalo, NY, 26 Jan 1983.

CFPD REVIEW MEETING

12 December 1982

Arvin/Calspan Buffalo, N.Y.

Vic Cronauer	RMS	703/920-5225
Phil Reynolds	Calspan	716/631-6715
George Hoover	RMS	213/454-9608
Bernard Eulrich	Calspan	716/632-7500 Ext. 5255
Jack Barry, Jr.	WPAFB, Ohio	AV 785-3853
Lt. A. J. Kirchoff	WPAFB, Ohio	513/255-3853
Stephen Shelley	Intermetrics, Inc.	617/661-1840
Bob Harper	Calspan	716/631-6836
Neil Akiyama	Intermetrics, Inc.	617/661-1840
Jim Dittenhauser	Calspan	716/632-7500 Ext.5280
Hal Green	U.S.- NADC	215/441-2029
Stephen M. Filarsky	NADC Warminster, PA	215/441-2088 AV 441-2088

Enclosure (1)

CFPD STATUS REVIEW

27 January 1983

ARVIN/CALSPAN, Buffalo, NY

Meeting Notes

I. Attendees: See enclosure (1).

II. Discussions:

A. Mr. Hoover reviewed the meetings with VADM Schoultz, DCNO (Air Warfare) and VADM Seymour (NAVAIRSYSCOM). Participants were informed of VADM Seymour's plan to take part in the flight test on 9 February 1983.

B. Status of the Phase II contract: The Contract to RMS was in process at Calspan and would be dated to coincide with Air Force approval to Calspan.

C. Status of the Class II Part II Modification: Air Force approval is required prior to the first flight. The entire package has not been submitted.

D. Mr. Berthe stated that a delay exists in the pitch axis of the display that is four to five times that of the roll axis.

E. Meeting was adjourned to start the ground check-out of the CFPD System.

Attendees: CFPD Review Meeting 27 January 1983

G. Hoover	RMS/SAI
V. Cronauer	RMS/SAI
S. Shelley	Intermetrics, Inc.
S. Filarsky	NADC
H. Green	NADC
J. Barry	AFWAL/FIGD
J. Dittenhauser	Calspan
C. Berthe	Calspan

Note: Not all program participants were in attendance due to a meeting at Wright Field on the X-29A program.

Enclosure (1)

APPENDIX D

Command Flight Path Display

Debriefing Comments

Debriefing comments of the pilots were taped upon completion of the flights. A portable tape recorder was used. In some cases the recorder malfunctioned and the comments were not recorded or were of such poor quality that transcribing was not possible. In addition to the following debrief comments, in-flight ICS communication was recorded on the video tapes and on the TIFS recorder. The original tapes were delivered to the Naval Air Development Center.

Debrief comments by Lt. J. Wetherbee
3 March 1983
CFPD Flight #03
TIFS Flight #712

Comments on ground simulation:

Awareness of upcoming airspeed changes, actually groundspeed changes, you have virtually no awareness of what you need to do in the future. You do get an indication that you have already screwed it up when the airplane starts going faster you know that you're already behind and it was time to put power on a long time ago. Sometimes you end up putting a lot of power on, going to military, and consequently using a lot of gas trying to catch up to where you should have been. There is no lead time at all in the upcoming groundspeed change. I don't know what the mechanization would be, but anyway, My second note was that throttle movements were higher flying the command configuration. I was always constantly trying to get back on airspeed. You get a very good indication of the upcoming turn obviously. You see the road up ahead turning and you know, here it comes it's time to start turning. Which is useful in some cases and very useful in the approach, things like that. If you tend to get slow, I was thinking that, maybe, this is again on the ground speed checks, if you get slow, the altitude is a little bit harder to read because he's so small and he's way up there, but I don't think that really affects you too much. My performance is going to be, still, real close to the altitude, I'll bet, even when I was slow. If you get low, then you lose the airspeed cue and in some cases when you get too far right he disappears totally and you don't have any airspeed - things like that. Like we talked, about a whole lot, indicated airspeed cue is a lot easier to fly than a groundspeed cue because it's not driving me to a proper position over the ground, it's simply getting me back to an indicated airspeed, which is one change - I need to slow down and get back on airspeed.

Some (velocity vectors) of those are even on centerline but the fact that it was crabbed out, you couldn't even see him. That's an easy mechanization to take care of by doing something like caging him to the display. Comments that I wrote down, like, we already talked about on landing and take-off. I don't have any airspeed or altitude cues other than the proper one that I'm suppose to be on - but I don't know what that is. I don't know when to raise the gear and flaps or if I've overstresed the gear and flaps - things like that. Also I'm very leary about transition.

I mentioned a couple of times about the fact that with this particular system, the command system, I had a very good situational awareness of my small picture, my near term, where I need to be in relation to the ground track, right here. I had very little indication of situational awareness to the big world, the big picture, where is the airport. Things like that. Then I started thinking well, that almost could be easy to fix too by just making my HSI a bigger scale. Showing me the airport, showing me the whole route, instead of just the portion of the route that I'm on, things like that. That's a possibility.

One thing that keeps going through my mind is that I lose flexibility

Lt. J. Wetherbee

by flying this command thing. By that I mean I can't go where I want to, or deviate, things like that. I need to stay exactly on that route. If I inadvertently deviate and need to come back onto the route, if I intentionally deviate then I have lost airspeed cues, position cues, things like that.

Corrections to desired ground track and also a lot of the flexibility problems that have lost by going to this in order for me to make a correction to a ground track involves two corrections. I need to first get back in the direction that will eventually narrow the gap on the ground track, and when I get to it make a recorrection. The other way if I were allowed to deviate, or be flexible and go wherever I wanted to, I could say okay, now to get back to the waypoint, and I simply turn to the waypoint and fly the new course to it. Again, probably an easy fix. For the future I can just hit it and say, "move my road over here."

I had some problems once in a while, they weren't big problems, just something I noticed, you'd get into situations where the contour lines would be sort of close to the highway and you'd lose track of which were which. You'd see a whole bunch of lines going, but it would only last a couple of seconds until you changed the heading or did something and you saw the highway continue to come. Then you could figure out which was the highway and which was the earth plane. This was especially true when we were in a position where the sunlight was on the display itself, where the difference in intensity in lines is apparent as it would be then, I didn't use that at all.

I'm wondering what it's going to be like and I realize we didn't do that, here today, but I'm wondering what it will be like flying over the mountainous terrain and not have those level contour lines in the earth, but have something different than that and I'm going to end up by losing my ability to determine whether or not I'm in a climb, or in a dive. Just by following the highway I'll know that I'm parallel to the highway but I don't know if the highway is going up or going down unless I have those contour lines telling me about this terrain. If I'm in mountainous terrain, it may not, it might.

In the ground simulator, not so much in the air, because I had trouble trimming it up, I'm still trying to figure out why. On the ground simulator I tended to notice airspeed changes more in the trim before I saw that guy moving. I'd feel the stick suddenly doing something and then the guy would go forward and I'd say "Oh, yeah I'm getting slow" and then have to add power which all that happens in some airplanes as for example, the F-18 which has zero speed stability. You don't have any trim change so my first cue is that guy is suddenly lurching off in front and I say, "Ah shit, I've already screwed up, and then of course you have to add more power to get back to where you're supposed to be. But in some cases that's necessary, there are some tactical situations where I need to get to a

Lt. J. Wetherbee

time on target and I need to be at a certain point on the ground and if I'm behind I'm going to have to add power and catch up. However, in some cases it is not necesary, like airways navigation. I don't want to go to full burner, military power to catch up.

The same thing on the altitude corrections, that I was talking about correcting back to track, in the flexibility problem. If I'm flying the command path display and it's commanding me to fly 1300 feet and I suddenly find myself at 1200 feet, there are two corrections I need to make. First thing, it's sort of easy to do, when you think about it, since you're flying formation and you do that a lot. You first got to get the nose coming up and then when you get back the altitude and then you've got to level off. That seems like something that I'm bitching about that I shouldn't be, however, when you think about what a HUD is like, a conventional HUD, which is simply a pitch display, if I deviate 100 feet, if that's within my tolerance I have one correction to make and that is to level off, to simply go back to zero. Then I can take my time about making the corrections and say to myself, well, I guess I'm 100 feet low and I ought to be up higher and then make the two different corrections but I can do them at will and I can correct for awhile and then go back. I got the distinct impression flying the command path that I need to do them right now and that I'm off altitude again, get back up, make two corrections, and I'm already deviated again, go back down and things like that. Once again that could be something that could be changed by changing the sensitivity of the display and the altitude display. Don't tell me I'm 100 feet off, tell me I'm 300 feet off and have me come down a little bit; or something like that. It's just something I was thinking about that with this command display making two corrections and you're always being commanded back to the hard altitude and you therefore have no flexibility, or reduced flexibility, I can't suddenly decide I want to fly at 1200 feet, things will tend to change in the future. Which is another thing I was thinking about coming back what this has applications for, the terrain flying IFR, low level type flying, though I hate to hear those words coming out of my mouth. Some guys in A-6's do that with their little computer graphics display.

Another thing that I thought was sort of strange was if you tended to be looking at the command display a lot, the conventional display you can sort of screw off and look around check other things if you want or look out for boogies maybe or something. But the command display always drew your attention to it and you're always constantly flying formation, constantly making corrections. If you ever did look away from the command display as a couple times I tried to look at the map to try to see where I was in the real world, when I look back, it takes you awhile to determine acceleration or deceleration. You don't have an instantaneous acceleration/ decceleration. I keep in mind I don't have that one on my other display, anyway instantaneously. I have to look at it for awhile and get to where my mind concentrates and I say, "Ok I'm accellerating."

Lt. J. Wetherbee

To sum up in the ground checks, when flying the symbology it seems like it's very easy to do the mechanics, the flying part of it I wasn't making very big corrections and I don't know what the deviations were from the performance. When will we find out about that by the way?

Flying the symbology, it seems like it's very easy to do that part of it, the motor skills part but it's a little bit harder to sometimes keep yourself abreast of where you are in the real world, big picture type thing, you have to constantly look at the map, "Ok, here I am," interpret the digital displays and things like that and the needles. It's a little bit easier in the F-18, I understand we're not evaluating the F-18, but the way their display works with the needle which gives me, the better analyzer informaton. So two things about symbology, easier to do the motor skills but a little more difficult to keep myself totally aware of it. The command display now buys me a great BN. I now have a BN that tells me exactly where I'm suppose to be, and I don't have to care about where I am in the world I just follow the symbology. I'll just follow it right into the ground, someday, probably. I have to work harder at the motor skills, you're constantly having to make inputs, corrections like that. Again that may be changed in the future by changing the sensitivities, making it a little more optimal.

So in some cases it's workload reducing and it seems in other cases it's workload increasing. My general impression was that I was doing on the command display, I was doing worse than I probably was, it looked like I was just doing really bad. Now I know I was within 600 feet on most of it. I think once I got out, once or twice, but it just gives you an impression that you're not doing a very good job of flying formation. Making a lot more inputs, lateral deviations in this particular airplane, I don't know if it's a function of the airplane but, lateral deviations, required an interesting angle of bank changes to get back and that changed my pitch or my altitude which gave me more changes that I needed to make. You're really flying formation and therefore it's a higher gain task and everything is interconnected. The other display, the conventional, symbology display you don't really get the feeling that you need to do anything right now. You can wait awhile. You don't have to continually try to get back to center line. If I'm off a needle's width which may be 3000 feet, I'm happy, sometimes.

Some things on the flight. The first thing I wrote was nose wheel resorance on take off. Some of these things are not in proper order, the first thing I wrote was the last thing on the command virtual approach and I found it very comfortable. It suddenly did not seem like a very high gain or at least not high enough as high as it was on the loop. It was not that high a gain of task. I was able to very comfortably, sit back and say, "Hey, this is pretty fun, I'm not scared at all." Two things made it easy. First of all, it was the indicated airspeed display instead of the groundspeed or position cue and the airplane was flying slower, like you guys said, the flaps are down now. I guess it's a better flying

Lt. J. Wetherbee

airplance. I didn't seem to have too much trouble maintaining center line of that highway. Initially I wrote that there's a very high pucker factor up on the route. You're constantly making corrections flying formation, you're constantly working, it's a very high gain task, but then I started thinking when you guys were flying back to make your approach, wait a minute, if it was good on the approach and not that high a gain of task and I was able to maintain the center line, you ought to be able to change the sensitivities or change the flying qualities of the airplane and make that a very low gain task and not that hard to do. But you still will have to constantly look at the display and you really can't take your eyes off it to do very much else. It won't be that hard to optimize it for up and away and navigation. You probably still won't be able to do that much unless maybe the sensitivities were de-sensitized so much that nothing would happen.

I assume there was a lot of wind. I would guess 15 or 20 knots, something like that, which is going to cause you to go out. I was thinking that the airspeed problem, the fact that it doesn't lead you or doesn't tell what you're going to need to do with your airspeed, started me thinking; the general concept of the highway is just like I'm driving a car so I know where I am going to need to go a few minutes from now and I just point my little airplane up there and it's very easy to fly down the highway. I'm trying to think of a mechanization where you can do that with a throttle setting and/or the airspeed. Tell me where I need to be somewhere down the highway. I don't know if you can do that or if it's possible, that would be affected by changes of winds also. But something has to be done about the fact that you're going from idle to military, idle to military. It's much easier on indicated airspeed. That is a function of the fact that it is not commanding me to get back to the position over the ground that I need be on. In other words when I'm flying the route if the commanded ground speed was 215 knots, I bet you it was very rarely 215 knots. Half the time, it was telling me to go 245 knots because I was behind. The other half of the time it was probably 175, because of the wind or because I didn't have the power set right and I was slowing down. I'd let the guy fly out ahead of me; I was therefore slowing down.

We already talked about the degraded airspeed cue with a cross wind correction in which should be easy to correct. One time we were only looking at the sidewinder. For some reason the concept of seeing, of having to deduce analog airspeed information from a changing relative size of something as complicated as that drawing doesn't quite seem right to me. Maybe an analog airspeed tape would be easier for my brain to figure out. There was something else I was thinking. I wonder how this is going to affect a guy who is just learning to fly formation and he learns how to fly on this? Will that effect how he flys formation on a real airplane. A slight loss of climb angle indication when the highway suddenly drops or turns. In other words, my indication of climb angle was I would just look out at infinity on the road and see whether or not I was above or below the

Lt. J. Wetherbee

horizon and I knew my road was inclined with respect to the earth level. When that road suddenly veers off like this and I get closer and closer I don't know whether I'm climbing or descending or what. Not that big a deal, in the turn, I guess, you still have the airplane over there doing this. It tended to be a little bit disorienting when you came up to a thing where, it suddenly went down like this. I got the distinct impression I was on a 3 degree climb and I was getting ready to level off. But not a big deal I guess. I'm just wondering how that ties back to the thing where now I don't have a flat earth, but now I'm flying over mountainous terrain, what's it going to look like and a terrain following type task. Am I going to get vertigo at 200 feet, thinking that I'm climbing or descending, I don't know.

I guess on the first approach on symbology, the ILS we broke out at 200 - 300 feet. It was basically unsalvageable. We popped the hood at 100 feet. I really haven't flown any flight director approaches and I wonder how close you can get on a flight director and R NAV.

I think a big advantage of this system is its inherent accuracy and ease of interpretation and I'd like to see it used in areas where we don't want or can't use the flexibility I was talking about; i.e., the approach phase and terrain following, where I'm not allowed to deviate from the highway or my altitude.

I was definitely having trouble with lateral separation, lateral errors along the route, due to something. It might have been the handling qualities of the airplane and it might have been the display log, I don't know. But I was having problems doing it. Now when you say I was having problems doing it, we've just flown for an hour within the 600 feet highway; the problems are as small or big as you want to make them.

I very definitely noticed problems on the ground simulator but probably not in the air. In the air, of course, I get the acceleration feedback, airplane motion.

Debrief comments by Lt. J. Wetherbee
4 March 1983
CFPD Flight #04
TIFS Flight #713

On the HUD, there were several things wrong with the HUD, one of which is the imperfections in the writing, the boxes aren't square, things like that. I had to drop off because of the speed slowing down. And you get flickering and jitter too. The flickering may be caused by the jitter. One time when I rolled out, flying the command, we rolled out just before, the final approach. As we rolled out, it suddenly stopped jittering and the flickering stopped and it looked like a really nice display all of a sudden, "Ah, gee, that looks great," then I remembered what you were talking about the bank angle. I rolled into a bank angle and it still looked good, it wasn't jittering anymore. It was just about the time we were slowing down, and dropping the gear and flaps and everything. Then a couple times it would go back to its old self again with the flickering and jittering and then it would straighten up again. Other than that I didn't pay too much attention to it.

That was my impression when I said that, I said, "Well, maybe it wasn't jitter, maybe it was flicker." When I saw that and then it all of a sudden straightened itself out.

I jumped in the left side and looked in. That was my first look at the HUD other than this morning, like I said the boxes weren't square, is what gives you some strange sensations when you're following the highway and it's not all there. Your eyes will tend to lose the picture and apparently or each other because the little view we were talking about which is about that big. It gives you a really strange sensation when it happens, when one eye in the picture and the speed that you move your head, it will all of a sudden totally drop out, it's very definitive line where the symbology totally goes away and all of a sudden you're looking like this at something. It's a strange sensation like we were talking about when you're flying. You kind of try to focus your eyes somewhere other than infinity when that happens, but it has nothing to do with anything, it's just kind of strange.

I flew the first approach on command hooded and Bob said the localizer was acting up, I guess the lateral crosshair was fairly accurate, we started three dots high and remained high all the way coming down the glide slope. Later on we did some correlation and some it's on the voice taping, how far off it was.

It was kind of interesting in that the work load was moderate, the manual work load was about the same as you get flying conventional symbology for that type of a task. In other words, the hand, the stick and throttle, and rudders. Manual work load was about the same. However, the mental and visual work load is a lot easier with this system. You don't have to think about anything you just react and fly it.

Also, not only that, but it's also constant going down the glide slope, I think I commented on that a couple times. The mental workload doesn't change as you get closer and closer to the ground as it will in a conventional approach. Conventional needles will change with different rates as you

Lt. J. Wetherbee

get closer and closer, there is sensitivity of those needles which will cause them to suddenly jump over, you got to do a lot more, you got to pick up your scan, and things like that. But the mental workload is constant going down the glide slope. It's pretty strange that on the first one, about ten seconds before the flare I get the distinct impression that our forward progress over the ground had slowed down or almost stopped. I initially thought the display had frozen and I was gonna yell, "fake it, fake it," but it was still working; I was still getting roll and pitch. It was still responding, but everything seemed to slow down and then all of a sudden it started to come back. It may have something to do with the fact that the highway had ended just abou. then or it was not very much of it to see anymore; it was just a couple of boxes left. The rest of it was just the runway. It may have been just an impression, now there was not very much out there except a few long vertical lines. I thought I was frozen there for a second. There were still some horizontal lines out in front that seemed to indicate that maybe it did slow down but I definitely got that impression—that it did slow down or something had frozen.

A possible enhancement, I was thinking of this when we were flying today, might be three dimensional boxes instead of this two dimensional flat plates. If you expanded them a little bit, made them a little bit wider and in fact, instead of them being strips, have them solid boxes. Something might be enhanced and it might even be a little better, but then you might have problems with the intensity of this solidness, make them thick instead of just one dimensional in thickness.

The second approach we flew it visual, still on the command display, in the HUD, as soon as you pull the thing down you can see that the HUD was depressed about 3-4 degrees below the horizon which gives some strange sensations. It tends to be a little disorienting because when you roll the airplane, the rest of the world moves one way and the symbology moves the other way. You get this kind of affect when you're rolling. You also got the distinct impression that you were diving down on about a 10 degree dive angle because the runway is down here, on the earth and coming down this 3 degree glide slope on the symbology but it is really a 10 degree glide slope in the real world. Perspective, the two runways were not overlaying each other, perspectively. It's going to be very important when we start flying this thing, if the virtual runway and the real runway are not matched up in perspective, one is longer or wider than the other one, you're going to get strange sensations, and one of the interesting things I think about this system is the ability to break out in a cloud cover and suddenly you see the real world and have been there before because you were just looking at that same presentation when you broke out, and if they're not matched you're still going to have the same type of a "where am I?" I'm starting a new approach, and it will take a while to finally settle down and say disregard the symbology and start regarding the earth. I think that's going to be fairly important to not get messed up.

Then we went up and flew a pattern on symbology. What is strange though, that as we went down the command glide slope it remained a definite

Lt. J. Wetherbee

line. If it was an offset in latitude or longitude that error would increase. You do not use the glide slope information. You use it to update the INS. We rely on latitude, longitude to land again.

We flew the pattern on the symbology, once again ground speed, probably the most difficult task, trying to keep under control. Digital numbers down there and you don't look at that, once every 5 seconds or so and you have to mentally integrate between what it was the last time you looked and what it is now, to discern any kind of deceleraton or acceleration. Work load is fairly low except for ground speed. Of course the tolerance is a lot higher and precision is a lot lower. We flew a command pattern as per our plan. I did some deviations and went way out to one side and way out to the other side and went a little high and got a flight violation.

When I went way out left of the highway and suddenly you feel naked, there's nothing out there, you don't see anything except the earth. The real world down there which is sort of like flying VFR without any instruments, except you don't have any indication of your flight path angle, or you sort of have an indicaton of altitude but there's nothing to reference it against. You definitely don't have any indication of flight path angle, especially from your angle because nothing is moving like this where you can see, yes I'm going toward the horizon. I guess if you were diving down, you would see the boxes and know sure enough I'm going that way. But if you're sort of near level you don't get the impression that, well you get the impression that you don't know what you're doing—you almost would like him to take over the airplane. We used the HSI at that point in time, but that of course gives you God's eye view, just tell you that the road is over here and I'm suppose to be up there so I'll keep it in military and I'll turn back. So you look down and turn back toward the road and get pretty close and all of a sudden you see it up there, but if you're level with it, you won't see very much because like I told you, it's a one dimensional flat road and you get no indication that it's coming up. You know and you just smack right on it at about a 30 degree shot crossing angle and all of a sudden it goes swooosh. Of course if you're offset, anywhere, then you will see it.

I would find it a lot easier if I were way above it, and harder as I get closer to the assigned, closer to the level with the road.

I would speculate it was not a mile off of the roadway, yet I got the distinct impression that I was off somewhere in no man's land, in outer space maybe, wanting to get back to my safe little secure highway. It wasn't very much, but I got the impression that I was very far away from it, that it was just a function of the precision of this display.

The workload, obviously, is reduced if you don't care about, it's strange, if you really don't care about being very precise on the road, it's very little workload. You can look around, comb your hair, do things like that. What happens though, if you're flying near the highway and you do something like that, like look away, change radio frequencies, if you look back up, if you're near the road, you suddenly don't know where

Lt. J. Wetherbee

you are, because the road is so close to you and you're in it, that same problem. If you're up above it, if you error to the high side when you're back at the display it's obvious right now that you're still along the tracks.

The times that I did that, the HUD was still covered and my mind had no trouble saying this is fake, this is real. If I had uncovered the HUD I don't know what the . . . although we did do that once, and it didn't seem to be too much of a problem because we were mostly IMC, and there wasn't a whole lot out there to see but clouds and haze. A couple times before the approach when we were totally uncovered looking around, it tends to be a little disorienting, because it's not level with the real earth, it rolls one way and the earth goes the other way.

Symbology on the approach: once again workload is a function of the distance from touchdown, as you get closer, pucker factor gets a little bit higher and you start getting a little antsy and nervous. I have a couple of comments about the wide field HUD, some of which have been already covered about the flickering, jitters, corners, drop outs, writing speed and so forth. We were talking about this before, we might include, detail on the airplane is probably too much, too many lines and stuff. You probably don't need all that. You definitely need to have a wide HUD in this type of a thing because half the time, when flying formation on this thing, most of the time, I'd say 90% of time I don't see the whole airplane, depending on the crab angle. Very rarely did I see the whole airplane unless he was way out in front of me and I wasn't flying precisely. The thing I like about this system is its precision and if I'm going to fly it precisely, I'm going to be close to the airplane and rarely did I see the whole airplane. So sometimes you need all that detail, like if I'm only looking at that one wing, I need a lot of detail on that one wing to be able to judge closure rates, things like that. That's going to be a problem, because like I say, you need a wide field HUD, otherwise it could present problems.

We also were talking about, and I agree with it, I've been very well trained over the last six years to fly very good formation, some pilots of course haven't, some pilots have never flown formation, I'm wondering how they will be affected by this, what their performance will be. Once again that flight leader is not very considerate he tends to scream right out ahead of you. I think we flew the whole pattern in military it seemed like, trying to catch up to the ground speed, I'm sure we had a head wind.

If you can do that, if you have the capability of displaying the highway, you have the capability of flying the whole thing. All I have to do is sit there, which will certainly help.

There are a couple things you can do, probably to make it more accurate in airspeed. First of all to make the display of that airplane a little better. I still don't quite like it I guess, I don't know. If I could see all of it at all times. If the HUD was wider, if I was looking at a 45 degree bearing I would fall off there, things like that. I thought of that (moving the velocity vector more toward the center) or even put

Lt. J. Wetherbee

it on the right side if I have a right crab angle, but you might have some trouble when you're close to zero with the guy jumping back and forth. Make it very definitive like when I'm looking at that guy up there in the airplane it's tough for me to tell whether or not he's out here or out here or whether or not he's moving slowly or fast. If I had more definitive information - that may even give you some problems too.

I personally don't like the whole concept of flying and having an airplane out there and flying on it. Another way that I might be able to control it better is if I put a F-16 type analog airspeed indicator with a commanded bug and my airspeed bug or something. I might be able to do a little better on it! I could certainly do a lot better on symbology.

That's right (I was honestly out there flying that real airplane as if you were actually in formation). For two hours I'm sitting there jockeying for one knot, trying to work on one knot. But I didn't do it very well.

If I'm crabbed, the closer I get to that guy, which enables me to fly more precisely, the more he disappeared which was part of my problem. If I've got him in my field of view way up there, now it's very difficult to be precise.

In turbulence there was some jitter in the display. I think it was turbulence related in that I'm moving up and down and my eyes are bouncing around. Keep in mind that is not something that is specific to the command vice the symbology. It's all the same thing.

The other improvement that I would like to see in the command display, not only the tape coming out to give me relative velocity information when he's far ahead, also I'd like to see the highway become three dimensional instead of just a two dimensional plainer surface. Then I could judge track crossing angles as I came up on the highway from the lateral direction. If it were a series of these things like this, separated far enough that I could see, if coming in like this that I was getting there, then I could fly like that. Things like that. And then I wouldn't be affected by things like if I were right on the highway I could see whether or not I was going this way or that way. A series of these things, I'm right on the highway I can't detect it.

The commanded ground position circle on the HSD is a very nice feature. The path on the HSD is on the F-18. I think they may have decided to take it out in the future but it is currently in the F-18 and you can drive your navigation route from point to point on the HSD and follow that. The HSD is very nice.

It was, in this case easier flying the F-18 with HSD in this type of presentation than a normal F-18 because we were flying cardinal headings N,S,E,W, all the time. If we weren't flying that it might have been a little more difficult, although I don't know.

Lt. J. Wetherbee

Those grid lines tended to be, should be a lot dimmer. They tended to be a little extraneous baloney that I didn't need on there. They were a bit overpowering grid. Ok, that's on the the HSD. On the up front control, the highway is certainly a very nice feature to show you the route. If they can make improvements in airspeed indicator that's a very nice feature too, if it can be improved. I don't currently like it, the way it's mechanized, like we were just talking about. I would also like to see extra information up there. Like velocity vector or at least an attitude reference point so I could know where I was pointing, probably a velocity vector is what I would like. Also you definitely do need airspeed and altitude, be it digital or analog information, presented to me when I'm in the landing or take-off phase so I know how fast I'm going and how high I am, things like that. I just know now, how I'm doing relative to the commanded airspeed/altitude and you need the options to display altitude up there and airspeed.

There was to some extent disorientation, when, like I said, if I look away and look back, if I was close to the roadway, I didn't know where I was and also when I was far away from the runway and nowhere near it then I also didn't know where I was and it was fairly disorienting and very disturbing. When we took the hood down and we're flying against the real world, of course, we did get that disorientation feeling because of the fact that is wasn't boresighted properly to the real world. It was depressed 4 degrees if you add that, it probably still is. Like I said, when I was descending I thought I was on a 10 degree dive angle instead of 3 degree glide slope.

Also, I tend to get a little bit disoriented when the road changes and goes like that and you sometimes think you're level and then think you're in a descent when you level off, but that wasn't a big deal.

If you're not looking at the HSD, then you have no way of knowing or you have little way of gauging track crossing angle until you actually go through it, unless you're stepped up on it and higher. Then you can see it looking down on it, you can judge it and get back on the road. Like I say you also have no altitude indication when you're off the runway too. If you had a transition path it would be as easy to fly as the one when you're on the route, I'm not sure you really need a transition path. How do you program the transition path and how does it know where I was last?

Where would it take me back to, where along the road would it take me back to? There are an infinite number of possibilities, several of which are probably optimum to a certain degree, some of which are definitely optimum.

I wonder what it would be like if you had a flight director mode, something like this where the highway was always directly under me. It was highly generated by my velocity, which in this case was zero, and if I rolled into an angle of bank, either it would recognize it like this or like this depending on whether or not you rolled the bank, relative or horizontal but if I commanded a turn rate, I'd see my road, this is

Lt. J. Wetherbee

my road now, not a pre-programmed road, but I saw my road go out like this. So now it's like a three dimensional velocity vector, it tells me where I'm going to be, it's sort of a trajectory predictor and I'm wondering if he can use that as a free wheeling transition path and get me back to the road in the method that I choose. What is the best method? It may depend on things that are constantly changing that you can't pre-program into a computer, things like road recky, if I'm running away from a bogie, or going in and out of clouds, or I don't know. If it's an IFR task, then there's probably only one way of getting back to the thing, if you're IFR there's no need to jink. What we are generating is an infinite series of transition paths, which is exactly this thing, I can instantly change my transition path by banking the airplane and pulling more G. There are various ways and there are various possibilities to solve it. I don't really know which one will be best. I really can't tell you. You do definitely need something to get back to the highway when you're separated from it, now I don't know what that is. But like I say, you do definitely feel naked when you're out there off the highway ... no-man's land.

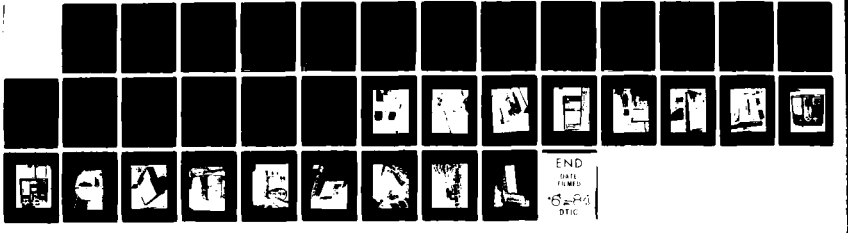
It must have been fine because I really didn't notice the flight path speeds being too fast or slow. It seems to be, it must have appealed to me because I didn't really comment otherwise except for that one time, that one anomaly, just before touchdown. Something happened and it suddenly stopped and I don't know whether it was. They definitely should be variable to give an indication when I changed airspeeds, well I say definitely, to some extent they should be variable. I don't want to see them whizzing by like that. It might not be a linear relationship but I would like to see them going by fast when I was moving very fast. That is just another indication of zipping by at a high speed.

I think it's going to be very important to get the systems boresighted and get the perspective exactly right for the runway that you're coming into, if you want to have a very smooth transition between IFR conditions and VFR conditions. Now maybe you don't really care if it takes you half a second to say, no it's not exactly right, I have to change intensity, turn off my CFPD, because it's giving me incorrect perspective.

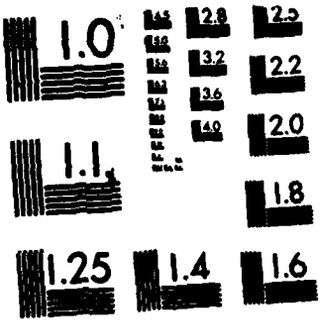
We should definitely continue. It was a lot of fun and George said he was going to invite me back to see the next updated version and I can't wait to come back and see it.

AD-A140 871 COMMAND FLIGHT PATH DISPLAY PHASE I AND II APPENDICES A - E(U) CALSPAN CORP SAN DIEGO CA SEP 83 CALSPAN-6645-F-12-APP-A-E F33615-79-C-3618 2/2

UNCLASSIFIED F/G 9/2 NL



END
DATE FILMED
DTIC



Debrief comments by Lt. R. O'Hanlon
7 March 1983
CFPD Flight #05
TIFS Flight #714

Airspeed control dominated my work during the flight. The altitude and azimuth control (flight path control) is a given, that out of the peripheral of my eye I could see the drift, left or right, up or down, depending on what the lead aircraft was doing, and, as such, it was really easy to maintain the track of the center line, meaning that I could see what needed to be done with the angle of bank oscillation. I was constantly wavering back and forth probably +/- 200 or +/- 300 feet, but you've really got something there with flight path control, altitude and azimuth.

The airspeed control dominated all my work. It may be that the airplane doesn't accelerate as fast. If I was doing throttle correction in an F-18, or any type of fighter, to try and maintain a position on the lead, I could have probably wound up the 25 minute circuit with 1000 pounds less than what my lead would have been flying a smooth throttle. The things that make me work harder are: when I finally got a stabilized position and could see some closure, when I saw something move, I made a correction but the correction didn't seem to be enough so I would make more of a correction. I noticed I was closing on it, I'd take some power off, still be closing at about the same rate, then I'd take some more power off and then all of a sudden it would stop. As soon as I saw it stop I would start adding the power but it was too late, it would be opening on me by then. Possibly suggest some sort of sensor that would look at the throttle angle. When I made my correction it would somehow slow me down and stop me from making an additional correction. It would try to smooth out my power. Another thing that might help would be some indication of RPM. When I'm flying cross country as a wingman, what I would do was, get in position, stabilized, look at my power, 83%, fuel flow or, whatever I'm going to set, remember that, and then when I had to make a correction I could go to 85%. When I saw my closure coming up I would go to 83% and then as I deceled I would settle right back into where I am. So that made getting in the saddle and staying there more difficult. There were no showing a burn light, speed brake popping out, or wing waggle - something to tell him I was about to do something, watch.

On the angle of bank thing, here I'm a little bit off the center line and not moving. I look at my display, I am in a straight-away but a little bit left of the center. I put in a little bit right angle bank to correct back to the center. I looked back to the display and it looks like I am in a slight right angle of bank to correct back to the center line but I'm not moving. So I go a little bit more, a little bit more, a little more and next thing you know I'm off to the right side. That problem was, even though there is a good horizon there, I have no idea when my wings are level. Bench marks along the side of the display would help me know when I'm wing's level and help me make small corrections.

You really got something there, for the take-off and landing phase of the flight, and even for the attack mission-sterile environment, no

Lt. R. O'Hanlon

fighters, no missiles coming after you, for navigation, etc., it's something that will display for you the path over the ground that you need, and in a data link environment, could show you a SAM site, and SA8 or SA9 that was rolled in and placed there overnight. It can be relayed to you and the computer will change your flight path around and all you have to do is follow the tiles and you can go around it, the slashing attack, which is now really being developed as a tactic. We're trying to get software into the A-7 to do an attack where you have a ground fixed target, you approach on a certain run, you go into an angle of bank, turn away from the target, and at some predetermined point the bombs will go off and hit the target and so forth. This type of display is perfect for that. What you are doing is just following the tiles with some kind of release cue which will come down and let you know when to hit your bomb pickle. During this type of attack, while the bombs are going off, you are turning away and getting out of there. You don't have to get so high, you can do this at 200 feet because of the altitude control. The altitude control is so easy on this display. I just went into what would be the utility or service suitability.

Again, speed control was the most important, I don't know what was the most difficult thing I did, and I don't know if it's that important to be honest with you. You could probably take the speed, leave the airplane there, because I love that airplane there for flying formation as far as altitude control, being step-up or step-down on the thing. I don't think it is that important the speed be controlled by that thing at all. It could be fixed article there - speed, the only thing I can see speed being important on is a bingo type profile when you are trying to maintain some stuff in flight. In flying it right now I would really like to fly stepped-up or not level with the lead aircraft: the safety pilots were calling me above the glide slope, which I would be if you wanted me to fly step-down. Maybe you'll think of that later on, because everyone flies a parade position differently, some guys will fly step-up, some guys will fly step-down. The Navy doesn't do formation landings. In the Air Force it's a little different in that you have your parade position and by God, you're locked into there because they do formation type land. In the Navy you don't do that kind of junk so that's why no one is hyper on exactly where you fly parade in a section approach. The point I'm trying to make is that when I'm flying level or slightly step-up on this airplane, I'm above the glide slope. When I'm flying the command display I find myself scanning about 30 percent of the time and flying 70 percent of the time, which is fine. When I'm flying the F-18 display I'm probably scanning 60 percent of the time and flying 40 percent of the time.

You'll notice I was using plus or minus about 10 degrees angle of bank oscillaton trying to trap the heading that I wanted to maintain a centered needle.

Airspeed control was, compared to an F-18, was easier in TIFS because the F-18 has no feel in the stick, you're always trimmed in flight. You

Lt. R. O'Hanlon

don't trim in an F-18 symbology. But everything else was rougher to do. The heading control was rougher and the glide slope was rougher. I have no doubt in my mind that the heading and glide slope control is almost touching simple with the CFPD.

Transition from flaps-up to flaps-down: when I transitioned to gear down with F-18 symbology on the first route, I climbed 200 feet before I realized I was climbing but when I transitioned the second time around I didn't transition to the landing configuration until I was about a mile, mile and a half from the glide slope, as soon as I rolled out of the last 45 degree turn on to the ILS final bearing, I said, "Oh my God, look where I am," as I was rolling out I called for the flaps. The thing is, with this airplane, placing that aircraft on the horizon and leaving him there even though I had no problems maintaining an altitude right then, I felt the transition was a lot easier with CFPD then, I felt the transition was a lot easier with CFPD than with the F-18 symbology, but again, that goes back to altitude control.

Debrief comments by Lt. R. O'Hanlon
8 March 1983
CFPD Flight #06
TIFS Flight #715

I'd be looking, I'd see a correction that was necessary and put the correction in, let it hold for a bit. Then I'd say, "I'm not seeing anything in the airplane but I am closing on the circle. I look up and I'm still not seeing anything on the airplane, I'm still seeing closure on the circle, I'm not seeing anything on the airplane. I'm closuring on the circle." Finally after the fifth or sixth time I'm seeing closure on the circle, something tells me I'm closing. I thought I did a pretty good job of documenting that on the tape.

I had a lot of confusion when I was well outside the circle, when I was well ahead, mostly, of the track because when I was ahead of the track I had to power back even more, and again I was talking so you can hear it all on the tape, and the little airplane was on the corner of the scope and was blinking at me, and I was confused at what it was trying to tell me. I thought that my goal was to, when I'm that far ahead of the track, to make the airplane disappear, but it just wouldn't go away. I thought he was blinking when you were outside the circle.

An alternate to how you have it set up might be, if you stick with the airplane, is when the computer senses that you have opened in front of it, your circle's back here (I'm talking about the HSD) when the airplane's up ahead, all of a sudden the computer senses that, that you are getting back to track, in other words you are getting back to the circle. You might just want the airplane to be the eye to come back up in the circle and stay there so that you know you don't have to take off any more power and that you're doing fine. You're doing something correct.

I analyzed, I thought, a little bit more of what I was doing, when I had a good picture, stabilized and had everything where I wanted, then something would happen to start the airplane to move forward or backward. I would make what I thought to be reasonable corrections in that type of situation—a little bit back or a little bit forward as necessary—but it wasn't enough. If that was a real lead I was flying on, and you were trying to make it like flying contact, when I made my reasonable correction, it wasn't enough especially when I was pulling ahead.

Flight path control - azimuth and altitude control: no doubt about it - was a lot easier. You can hear from the tapes how much less I was scanning and how much more I was flying with the CFPD. There's no doubt about it - you fly the airplane more and you scan less with your display, but I'm still not convinced that flying formation on the airplane is the best way to fly. But the "Yellow Brick Road" I like. The airplane is good because pitch control becomes a mere fact of putting that airplane and the horizon where you want them; stepped-up, stepped-down or level with me.

When I was flying F-18 symbology around the pattern we were in a bit of turbulence—about moderate I would call it. I didn't notice it

Lt. R. O'Hanlon

too much on the other. I had a pretty hefty cross wind a couple of times with my display, I could really tell it - you can't notice it with Command Flight Path Display. You could if you notice how much crab you have in your aircraft on the HSD but I didn't pay attention to it. You notice it with the velocity vector because he's out to one side or the other. The reason I mentioned the turbulence is because I could feel it but I didn't notice it in the display.

On ILS final when you have all that drag on the airplane I thought it was a little bit easier - when you take off the power your airspeed is dropping now. On final with the gear down I found it easier to fly. (Note: safety pilots were using only flaps for landing configuration.) On F-18 symbology display I really had to work hard to maintain an altitude with stick force changes when the flaps were coming down or transitioning, but I didn't notice and didn't think I was working that hard on CFPD during transition which is fine because when you're that low to the ground, transitioning, for something to make it easier.

One nice thing about the CFPD, you'll notice it when I was shooting the ILS and the pattern work. ILS beam expands as you get away from it so small deviations, as you get close, will make the needle move a lot faster, so you'll notice that when I got in close, the needle dropped off the bottom. As I got in close, I realized I was getting close so I was starting a flare. On the command display there was no tendency to do that. I stayed locked on my little airplane there and did whatever he did—if he flared, I flared. There's not a bit of trouble flying airspeed on the glide slope. Once you are flying indicated airspeed it's easy. I see a lot of mission applications for this type of display; attack navigation, etc. If you were to put this into the ACLS system—which would be great because the glide slope is so good—there would have to be a lot of modifications, something to the ship also. I'm thinking if he comes down and traps and everything is good, that's fine, but if he bolters or gets waved off, then you're going to have to command him around the ship. Right now ships can only talk to you when you're lined up right there on the final bearing.

Part of the speed control problem is if you are locked in co-speed with the lead, if you move away to the right of the tiles, it's going to look like he's coming back on you, and conversely, if you go in he's going to look like he's going forward in that 2-D image, so I really concentrated hard on trying to stay in the center. Even though I concentrated on that it was still easy enough to put an equal amount of concentration on speed control.

Speed of movement of earth grid on VSI and HSI: just right - did not bother me or didn't impress me. I would add DME and a gauge to tell you how big each of those squares were, 5 miles long or 10 miles long - the scaling.

Lt. R. O'Hanlon

Time delay: It would take a while for a correction to become visible on the display. Yesterday I was oscilliating in my angle of bank. I was constantly trying to stay on the centerline, constantly moving my stick. Today I thought it was steady even with the turbulence.

Pitch rate, flight path control, some indication on the command flight path display of how much correction to put in, such as superimposing the velocity vector on it, would be helpful to maintain these small minute corrections.

Speed Control Suggestions
- a) Numerical A/S
- b) Color
- c) Signal from lead
- d) RPM gauge - analog tape
- e) Angle of bank bench marks - centerpoint for wings level

I can't over emphasis the landing phase. This display is a lot easier than any of the other displays I have ever flown. I'd like to see the next phase. I'd like to see it in a fighter.

The thing we haven't talked about yet - maybe this can generate some controversy - is for a cat shot for instance, maybe you have the flight path right ahead of you which you can climb out on and also something that gives you an indication that you are flying, because if you can't keep up with that pathway then you're going to have other indications that that cat shot probably wasn't a good one. It's good for that too.

Debrief comments by Lt. CDR J. Walters
9 March 1983
CFPD Flight #07
TIFS Flight #716

I find it easier to fly than on ground simulator. There is a theory expressed about lead and lag times and the display delays; I've got no opinion as to whether the theory is accurate. It felt more comfortable, I guess I didn't notice delays, but responses felt more normal to me. Other than that, it's very much like flying the ground simulation this morning. All the comments would be the same. I had a lot of trouble on airspeed in the flight path mode. A good part of it is because I got no cue. I don't know how fast I'm supposed to be flying, how fast I am flying, and when I know I have to go faster or slower. I don't know where to set the power. Now if we're flying close formation on a lead that's moving smoothly that's usually not a big problem in natural practice. I found that when I was trailing this speed bug by an appreciable distance, indication of closure or increase in separation weren't quick enough, or fine enough for me to see or anticipate changes. It's hard to anticipate a slight closure as compared to a planned decceleration of a bunch of knots. So what happens is I get pretty high, pretty substantial closure rates. The same problem manifested itself to some extent flying the symbology just because I never knew where to set a power setting and I would get to 215 knots and I would set it, figured it was about good, and next I would look down and I'd be 218 and have to take more off. I'd go through that three or four times—go up to 230 knots, and that's just a big airspeed differential. On a normal airplane you'd just check a fuel flow setting and you could probably set the throttle within a couple knots, so in that sense there is a little non realism there. In the symbology case I would normally see it. In the CFPD it would have been helpful. If anything it would have given me a chance to anticipate the stuff. Like we said this morning, I'm not sure that degree of precision is essential in practice beyond what you're trying to see here, that is, if I am capable of flying it. CFPD is easy to fly in the air. I would be curious to see the tapes as to how far I deviated in each one. I'm sure it's a lot more on symbology.

I was having problems anticipating speed changes and I found that I could use the how goes it circle to anticipate. If I saw myself drifting appreciably out of it, it sometimes cued me to a magnitude of position change a little bit faster. I started using it for that from that point on. I felt pretty comfortable on the Command Flight Path. On the symbology one I didn't do particularly well. I just never got on top of it. I felt like there was a good cross wind because I was carrying almost 10 degrees left on the glide slope and never did get a localizer centered on the symbology approach. I landed right in the Command Flight Path too, and that's all I could figure out. How does the CFP compensate for wind? It felt comfortable to me. I knew that I was not flying down the road in a straight and narrow direction and I never quite got comfortable with that. I guess that's what you're saying - that there's a built in crab and I was a little bit off centerline to the right. It kept looking like I should be driving over there but I wasn't, and it was probably my failure to appreciate how much wind was blowing.

Lt. CDR J. Walters

I didn't have any problem with slight turbulence, but I did notice that I had to work harder to see the stuff, which you expect in turbulence. It will be interesting to see how it really shook.

On pilot experience: I've got 100 hours in the last fiscal year and maybe 40 in the year before. My A-7 does not have a HUD so I don't have a lot of HUD time. I have an appreciaton for how the HUD symbology works from head down on the A-7.

On flying simulator vs real: To me it felt more damped in the air. You didn't overcontrol as bad. You had an easier time keeping wings level.

Debrief Comments by LCDR J. Walters
23 March 1983
CFPD Flight #08
TIFS Flight #717

I had more trouble flying the CFPD this time than I ever had before. I'm trying to attribute what the difference is and I guess my opinion is that there's a whole lot of things stacked up. One thing is that we flew with the hood down and I was constantly uncomfortable with the attitude of the airplane when it was telling me I was flying in the right direction. I noticed, it came out later on, that the path in the sky appears to lead you pretty much into the dirt. It's really not aligned with the horizon very well, so I was getting normal sensory cues from outside that said my altitude was good or bad and cues on the CFPD that I think were different. There's a lot of times, knowing that there was no descent anywhere on this part of the route, that I felt like I was really coming out of the sky. On top of that the whole thing started out bad - we started out lined up in the center of the runway and as soon as we engaged I scooted about 100 yards off the left side of the runway so there was a control input from somewhere (Note: false start from safety pilot). I started back trying to recover and the trim was way out so I spent the first two-thirds of the turn trying to trim out all the control inputs and it was a long time before I felt I got trimmed. So I really never got very stable until about half way through the course. The other thing that I told Vic later on in the flight was that I didn't notice until I was almost all the way through it. When I took down the shade and it was lying across the back of the HUD about three quarters of the way through the route I realized that the first two plates in the display were sitting behind the piled up curtain and they were essentially out of my scan.

That was compounded a little bit by the fact that I don't think that HUD is bright enough to fly against a snow background. You can see everything but a lot of times you have to work to see it. When you have to work to see it, the advantage of having all the nice sensory cues in front of you is lost. So I'm sure that I flew that whole first pattern, even after I discovered it, without benefit of the two closest plates, which I think give you a lot of sensory line up. On top of that, there was no warm up in the simulator and I haven't flown anything else in a couple of weeks and I think it was just a little bit of clumsiness on my part. Strong winds had a lot to do with airspeed, I couldn't understand ground speed for a while because the marker would be telling me I was right on track and I would see the indicated airspeed change a knot or two every time I made a turn. I would be deceling the indicated airspeed and acceling like a bat out of hell on the ground speed because there was a good stiff wind and every time I turned in and out of it. I've reverted to symbology now not CFPD. Symbology was where that occurs and that was just difficult to control ground speed.

On top of that we varied from one to two balls out of rudder trim. So, when I was flying down the CFPD I was sitting sideways on the seat and I got no indication of trim, and I got cues from the display, cues from the ground, and cues from the seat of my pants and nothing to confirm them against. Confirm I point the airplane down the middle and kind of

LCDR J. Walters

out the side and it was giving me fits at the beginning until they casually mentioned that maybe I ought to use some rudder trim. We had never touched rudder trim the whole last time we were out there. It seemed like there was a whole lot of wrong trim in there when I took the airplane the first go round. The rudder was way out, I told you I had right wing down, I held the right wing trim button down for five, ten seconds at one point in time and it just didn't feel right. I may not have been very far off but it didn't feel good. I'm still convinced that if it was an A-7, which I was very comfortable with, I feel like I could fly down the middle of the path and just never deviate from anything. It's a different aircraft, feels different, not as stable, not as comfortable. I never know where the power is supposed to be because I've got no indication.

I did not have trouble with the velocity control. I didn't do particularly well on it, but I did way better than last time. I think any problems I had with it this time were largely a function of the fact that I was really tight in the airplane most of the time.

The other problem we saw in the approaches, the velocity vector and the horizon are not where they are supposed to be. To my discredit, I didn't notice that until I realized all of a sudden that the velocity vector was buried about a mile short of the runway and I still wasn't coming down on glide path and that caused me discomfort so I was never really willing to commit to the correction it took to get down there. Then we checked the horizon out, and the horizon was way below the horizon so that was why the whole thing was pointed downhill, and I think that is also true of the Command Flight Path and that's probably why I have a little discomfort. When you put up the screen it doesn't matter, there's nothing to confuse me and it feels just fine.

Note: Safety pilot's comments about offset on glide slope during approaches:

In the final portion of Symbology I was going high and that's why you would see a jump. It was very sensitive there and I would go a little bit high but the CFPD I found interesting. The needles are real precise and they were sitting there calling what they were seeing to the guys in the back and on needles that didn't bother me at all. If they said I was a little bit high and my needles were right, that was fine, I've got no reason to do anything. But CFPD there seemed to be some variability in where I could fly and still be comfortable. When we were coming down on CFPD and everything seemed just hunky dory and he'd call, "Right on," and I'd say, "Yeah, right on." Then he'd say, "Going a needle high," and everything looked fine to me but I would correct automatically. It was just like having a GCA controller. The other thing was that in close, where the needles get more and more precise, it seemed like CFPD in really close, last time we were 200 feet didn't seem like it was because on CFPD I felt like I was flying just exactly where I wanted to be when we crossed runway threshold and you guys would come up and say we're going way high or going way low. Now that may come with practice, knowing what it looks like when

LCDR J. Walters

you cross the runway threshold but I thought I was right where I wanted to be all the time, plus every time we got close I'd get a little bit worried.

The airplane feels so different from a jet. A normal correct threshold crossing altitude and attitude is uncomfortable so I never feel like I'm right. I feel like we're too low and the nose is too low. So I'm really dependent on the symbology to cross the threshold.

Debrief comments by CDR Fred Ameel
24 March 1983
CFPD Flight #09
TIFS Flight #718

In general the CFPD display drastically reduces the pilot work load. With the curtain down I had some problems seeing some of the imagery, whether it was symbols or CFPD, I just couldn't get it up bright enough. On the ILS's the velocity reference, without any power or attitude changes, was getting a lot of surging back and forth on the lead A/C. I didn't notice it on either of the first two approaches around the circuit. I didn't have any problem staying with the lead aircraft. I would have liked to have had less relative movement from a personal standpoint, but I could stay with him. It just seemed like I was doing a lot of jockeying. But, I thought if I could get tucked in there, for the power changes I was making, I shouldn't have seen that much relative motion. The one addition in the symbology there, or velocity reference, is some sort of anticipatory signal when he accelerates or decels. Sometimes I would be looking down the road and all of a sudden I would pick up that he's stepping out or he's sucked power and he's coming back - that would help. Just like formation flight when the guy goes on the head nod or hand signal. So you can anticipate how to react.

I was step down on your velocity reference. It has definite possibilities for terrain following. When you're going from point A to point B, yes, but when you say tactical mission you have to define what you mean. I don't have any problem with terrain following as long as I understand what the program is supposed to do. I've studied it. The biggest thing, to accept a system like that, you have to gain some experience with it and you have to have confidence in the system. We were talking about that when the A-7 came along and they slapped the HUD in there and said, "Hey, let's go flying." Yet, they left the whole hard instrument panel in there too. Well, most guys like myself never stopped looking at the hard instrument panel. Hell, if the HUD is so good, why did you leave the other stuff in? But I think it has possibilities - for the terrain following mission it definitely has. If you can shoot a precision approach you sure as hell can fly some set altitude over the terrain. Overall, it greatly reduces the workload, the mental computation of trying to say, "What's really happening now," of cranking the numbers around in your head.

My only scan was between the aircraft and I would look at centerline every once in a while and I would say, "Let's get back on centerline." That was the scan. I looked down at the horizontal situation there once I figured, hey, that's showing me my relative.

I liked your idea - as you got closer to the runway, bring the airplane closer to the tiles and if you're flying on that, it's going to bring you right down to the horizon. Before I asked you the distance between the two, I assumed that the velocity reference was on glide path, on centerline, and all I had to do was match him. So I'm off whatever the distance between the cockpits. When I was in the aircraft I said, "Hey, just like shooting a section approach." I may be 15 feet lower than he is but that's not really important until I get in real close.

Debrief Comments by VADM E. R. Seymour
19 April 1983
CFPD Flight #10
TIFS Flight #719

I thought it was very realistic but you'll have to look at the tapes to see which I did better on. I thought I did better on the Flight Path Display. Steve ought to be able to tell us, somebody. Which did I do better on? Oh, you have to check the tapes. Could you watch it back there - could you see the same display I was on? The vertical display looks superb - no the horizontal looks superb, the vertical was not that good.

You really have to figure out where to fly. I found that flying too low to the road is too hard and I was more comfortable up with the airplane, but that's 150 feet high. So I was trying to find a happy medium. You can't fly it close wing on the airplane. I'd rather be up close to him. I find it a heavier workload when he's that far away. But that's the way I fly formation. When I got up to where I wanted to on him he was blinking all the time. He then disappears and then I couldn't see him and he starts to flash.

I guess two hops I would comfortable going IFR in it next time. I think it was easier with the Command Flight Path than the ILS but then I'm not an ILS pilot. Never was - we didn't have it in the Navy until I stopped flying. Then they put them on the carriers. ILS tends to be that way (higher workload) but you have to integrate where you are. If it's not all there, you have to put the range into it in your own mind as to how big the correction or how little the correction. But I would be very comfortable with that control panel there.

The simulator helps you get a lot of the rough stuff on the HUD. I was a lot better on the HUD in the airplane than I was in the simulator. They're all the same (EUDs). None of them are good until you're used to them. Once you're used to them, you're comfortable with them. That's sort of my idea of them. Oh, I couldn't tell a difference but it's been a long time since - the last time I was very familiar with it was in the A-7. I always felt that was plenty broad enough for me. I could see all the picture. I never had any problems with it, but I haven't flown one in 12 years. I'm really not up to date as to whether that's a good picture. It looked to me like a picture on a HUD. Once I figured out where the gauges were on the HUD, I watched the gauges on the HUD.

What are we planning to do with it? It may have a future but I don't know. Like if we had wanted to go into Buffalo instead of Niagara, we couldn't do that. How could you do that if I stick it in an F-18. In order to reprogram it, do I carry Steve along with me? How much are they in production?

The line drawing I got used to. I don't know, it would be nice when you get to the advanced computer graphics for it to look like a real airplane. One thing that you should add though is the gear and flaps command. Let the airplane drop his gear because my problem with this airplane is I didn't know what airspeed - I cannot ever tell my airspeed - what it is - when

VADM E.R. Seymour

we started climbing, I thought we were slowing down and starting to go down. I felt like, seat of pants, it felt like I in was down to 130 but theoretically I was in a climb at 185, chasing the little airplane. And so some indication of speed would be useful and maybe it's just dirtying up the other airplane, or I don't know what.

I'd probably bring the airspeed up on the horizontal. I wouldn't put it on the vertical. At least I wouldn't think it would be needed there, but somewhere out to check. Of course, if you were commanding it yourself, in a single seat fighter, and you know you were going to make an approach, you wouldn't turn the thing on probably until you've started in for your approach and you know you're coming down the slope, you're going to level off, hit the marker, and going for the numbers. Doing a pattern like we were doing today, I was absolutely convinced that we were descending and I should be putting the gear down when we were climbing. Supposedly climbing - right Vic?

So the idea is to control program anything into it just like you can with your waypoints. Could you fly cross country with it if you wanted to? You could put it on there and see how good the autopilot is.

I guess there are only two things I would add to it, some indication of letting him be able to see airspeed if you want it or needed it. The other one would be - there is about probably a 10 foot range where it is absolutely totally useless, but I don't know how far it is, but when you're on the road, you can't see the centerline of the road so you've got a 4000' foot wide line. You know you can stay within the 4000 feet but you don't know where the centerline is unless you get up a little or down a little. I suppose that's not sensible. I don't know what to do when you get there, you can't change the picture too much. It's going to be hard to do on a carrier you know. You can't give the guy more than 3 feet of leeway on the carrier. If he rides the path - right now he can ride it from 0 to 150 feet high. If he rides it 6 feet high instead of 3 he's going to bolter. So there's got to be some way of taking it up for the carrier approach. As long as you stay below the airplane you catch the wire, as long as you stay above the glide path you won't get the ramp. We ran into ILS problems, that's too bad. It's worth trying for another day. See how we're doing for time off.

On the approach to Niagara we were way high. I don't know if that was because of the set up or what. I was above the roadway. I wasn't that far above the roadway, but I was well below the airplane. When we were talking about it, way out at 5 miles, I was up by the airplane but from about 3 miles in I was nibbling on knee-high on the road and still out of my scan I was high when I looked out the window.

Inside of 3 miles I wasn't anywhere near the airplane. I was down on the road. In fact I went below the road once. Still when I looked out the window I was at least 100 feet above the glide slope and lined

VADM E. R. Seymour

up. I figured that might have been just the altitude and the altimeter. We had an altimeter glitch up front from the main airplane and after they reset it, it was only fifty feet off. That may have had something to do with it.

I would be comfortable with it now down to 200 feet. I think I would like to break out of it at 200 feet. I don't think you can go zero - zero yet, 'til you know for sure that you get the right stuff.

One hell of an improvement human factor wise I think. I was working more on the HUD than I was on this. You know you're only scanning two things - whether or not the airplane is accelerating or decelerating and where you are in relation to the road. Which is really a measure of three things at once probably in relationship to the road. On the HUD I had to keep looking around for altitude, whether or not I was climbing, I had to watch airspeed on one gauge. It wasn't all that easy; finally got smart and converted that to this up here, and started flying off this - I wasn't supposed to. You're bound to do that after you figure out where the scan is and you've got somebody up here that will do the same thing. That was the other thing, on the approach here I was just monitoring the HUD, and the HUD speeds are, at touchdown, about 5 knots above the pilot speeds, and back out at the marker, about 8 knots difference. It wasn't linear, it was a decreasing difference, but there was a difference in indicated airspeed on the HUD and on the airplane.

Thank you I enjoyed it very much.

Debrief comments by Capt. R.D. Friichtenicht
19 April 1983
CFPD Flight #11
TIFS Flight #720

NOTE: Poor quality on the voice tape allowed only a partial transcribing of the comments by Capt. Friichtenicht.

I did feel much more comfortable in the airplane than I did in the simulator. It seemed like it was a thousand fold better. I didn't have any trouble at all, at least knowing what the hell I'm doing now in the airplane. One thing that kind of surprised me was, if I can back it up, I feel my ILS approach with the HUD was quite a bit better than my ILS approach on the CFPD. The only thing that I can think of is there was some fairly good winds out there. I kind of got myself off course and a little bit behind and I never quite caught up. I was chasing it all the way down the flight path. It just seemed like I was at the edge of the pattern all the way down. Could you tell that back there where you were? I know I ended up high.

It's probably a quirk but I think I tended to fly on the right side of the intended centerline. I had another quirk that I'm heavy on the rudder. I think Vic kept trying to trim the rudder out but I had my stupid foot on it.

As far as the course that I took, I felt much better, much more comfortable on the flight path than I did with the HUD presentation, but I couldn't have made it without him reading off every airspeed and heading and even then I was fast most of the time. I think that the new capabilities are surely there. I tended to overcontrol that a little bit, in the controls. I would hold in my correction too long and I'd drift off to one side, and then drift off to the other, around.

That was partly, I know in effect, I mean I can tell, again, the little airplane was below the horizon so I was above the horizon. So I was at least 150 feet high according to your display. It wasn't the display's problem. But then again I wasn't quite sure when you're coming down the glide path. I know when you're straight and level, as long as I kept the F-18 above the horizon, and me above the road, you're within the 150 foot corridor. When you start descending I wouldn't quite know where I should put him. Should I put him above the horizon, even with it, or not. So I tended to be a little bit more of what I would call trail, which probably kept me high all the way down.

They asked for power twice on the last ILS approach. Both times it was a case were I was slightly right of the lead plane. I think I was still tending to automatically crab because of the wind and I was over running the F-18. (tape garbled) When I was flying the flight path director (command flight path), I tended to make sharp, short corrections. It was a lot easier on the flight path director. (tape garbled)

APPENDIX E

Command Flight Path Display

Hardware Installation Photographs

The mounting locations for the major CFPD equipment items are shown in the following photographs. All CFPD equipment, with the exception of the graphics processor and the video recorder and power supply, were hand mounted in the aircraft. Equipment locations, except for cockpit displays, were selected for aircraft center of gravity considerations, ease of operation by crew members and accessibility for maintenance.

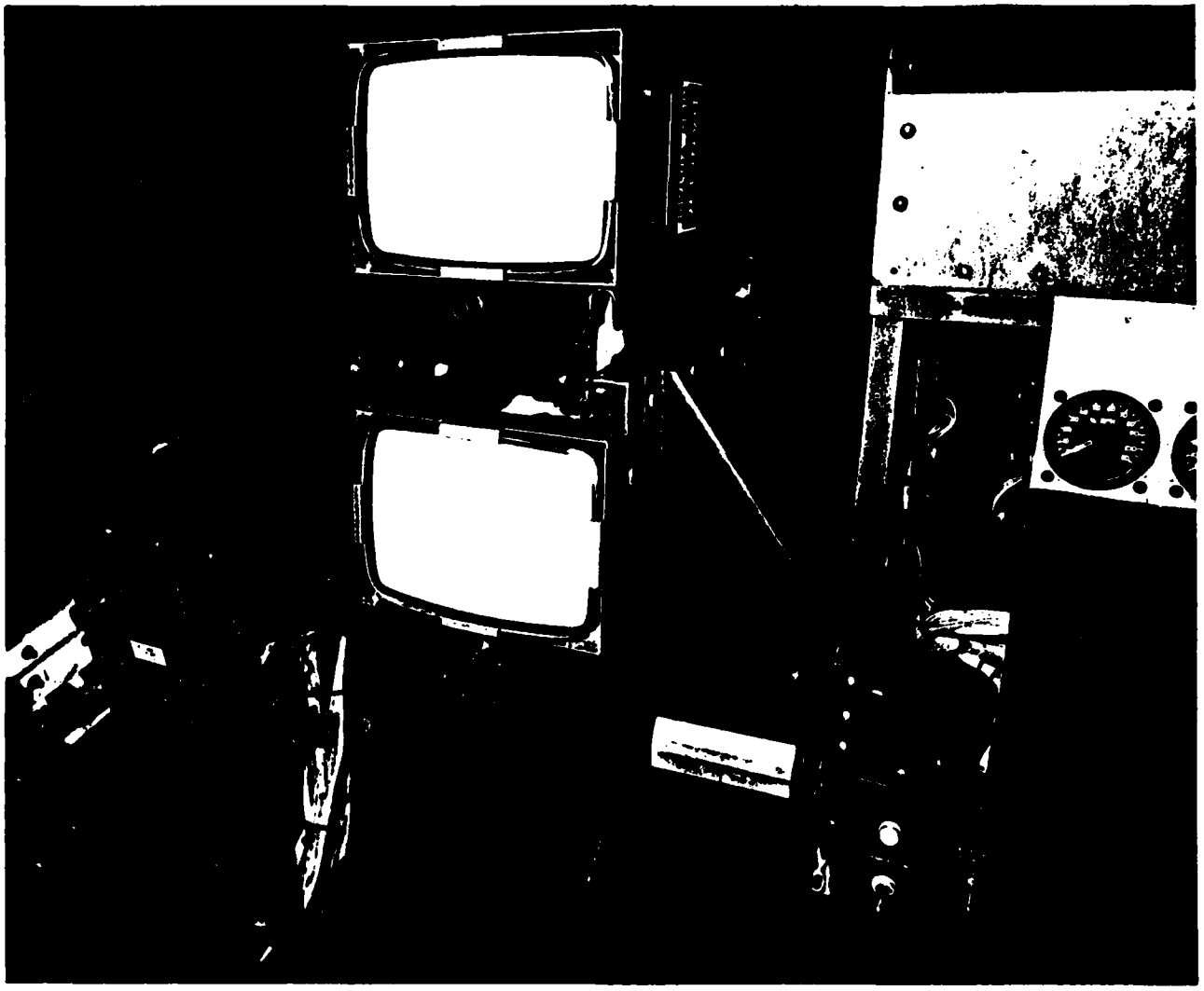


Figure 1 XYTRON VSI AND HSI DISPLAYS

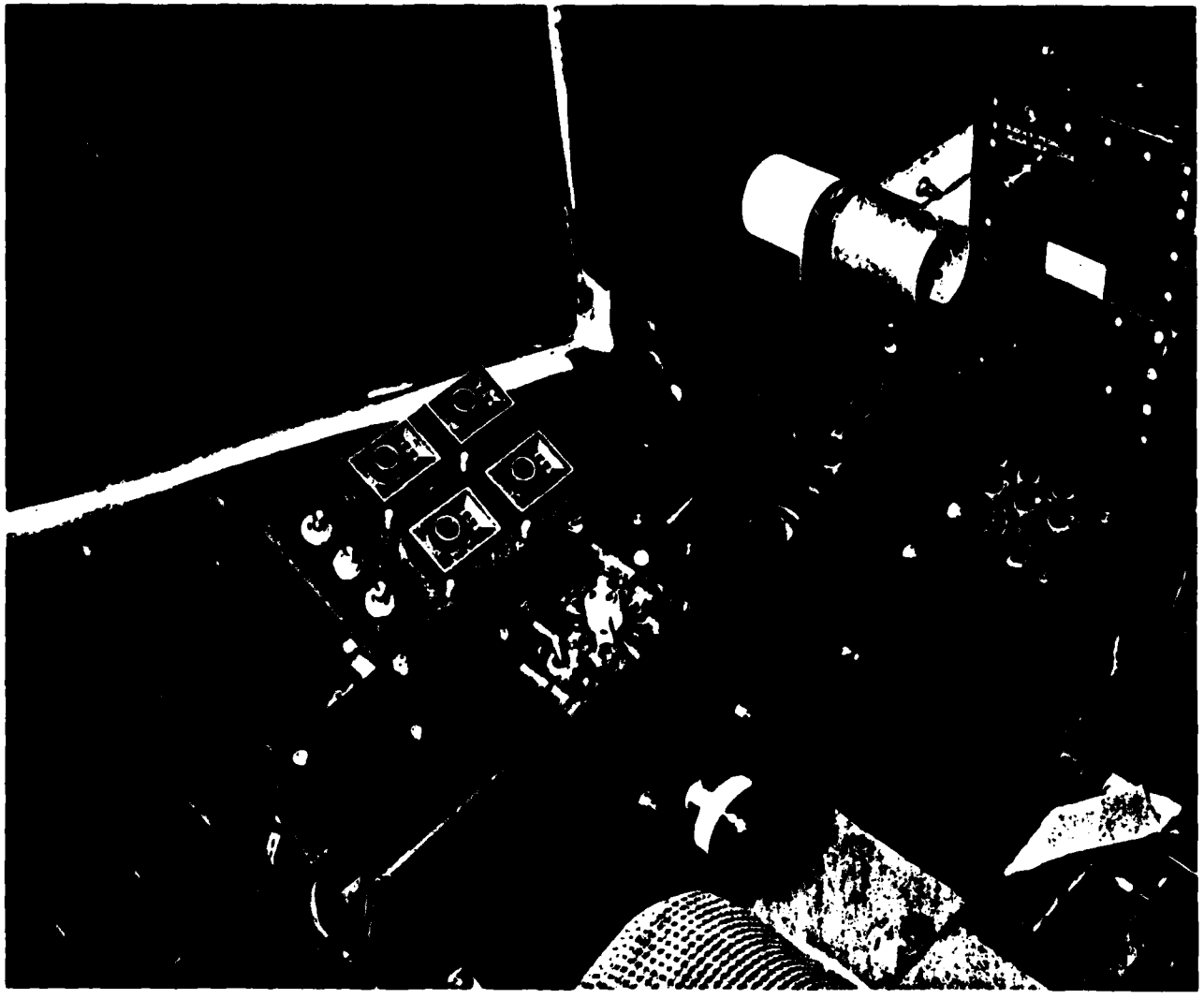


Figure 2 LEFT HAND THROTTLES AND CONTROL PANEL

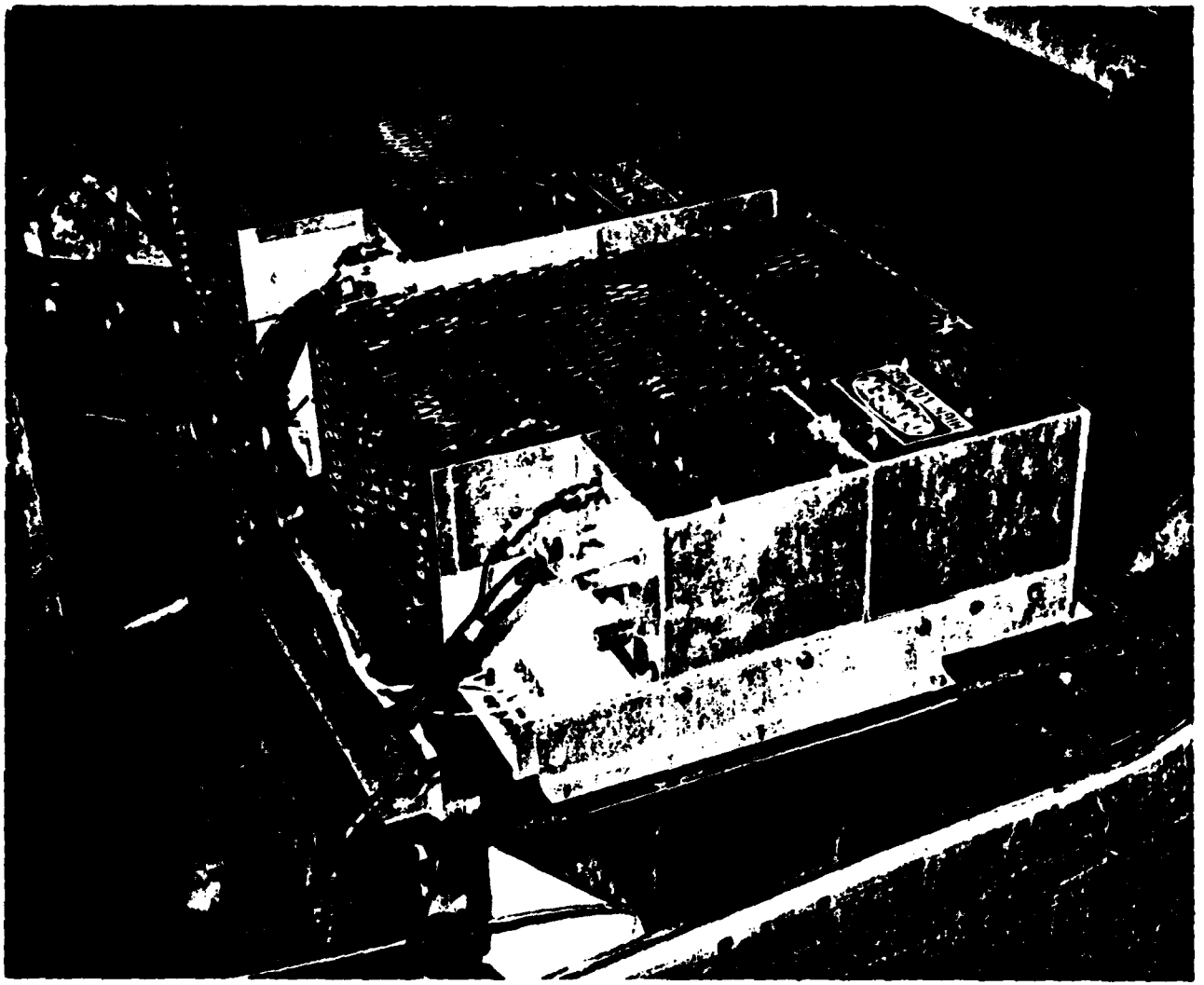


Figure 3 XYTRON DISPLAY DRIVERS

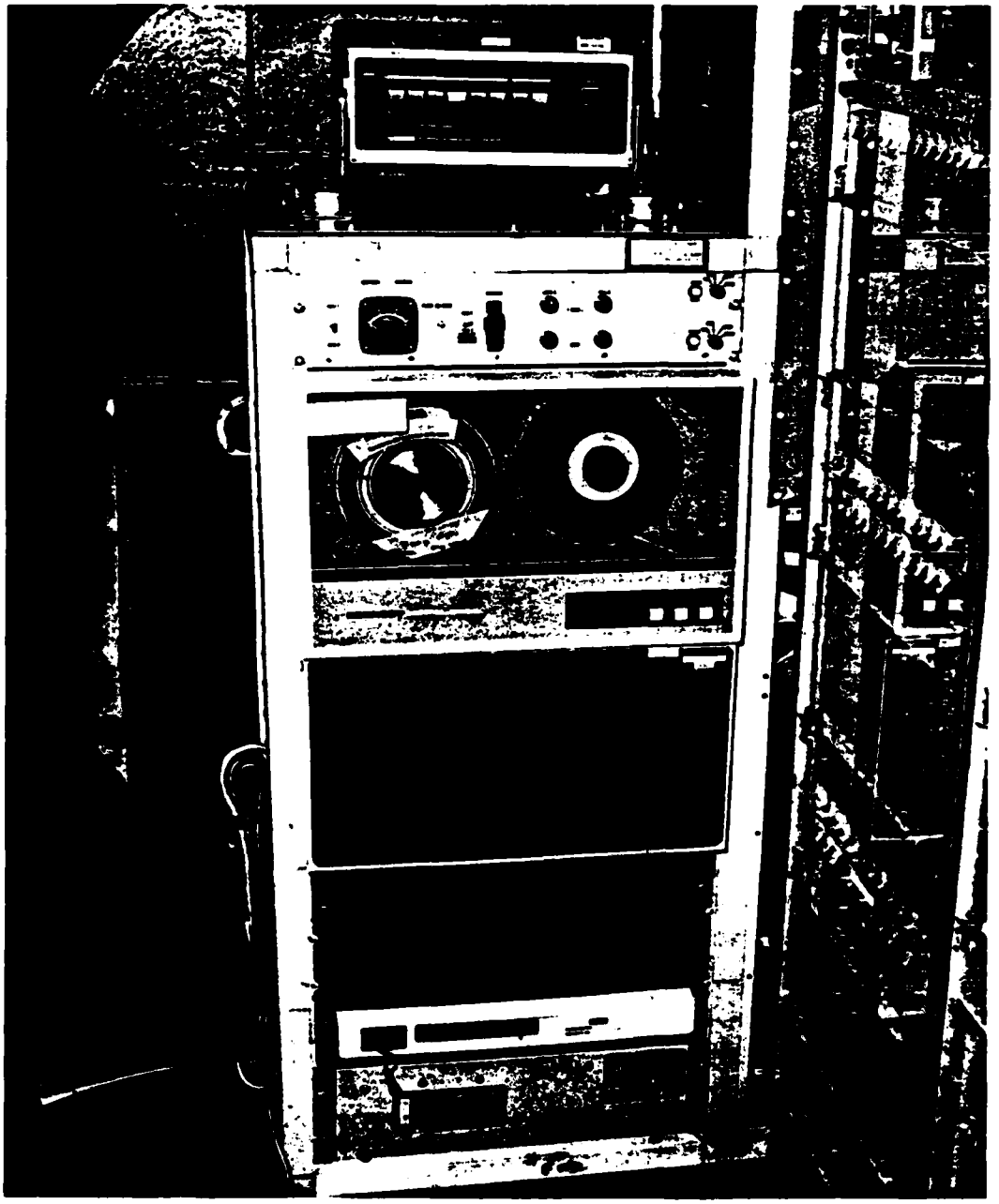


Figure 4 CFPD COMPUTER RACK

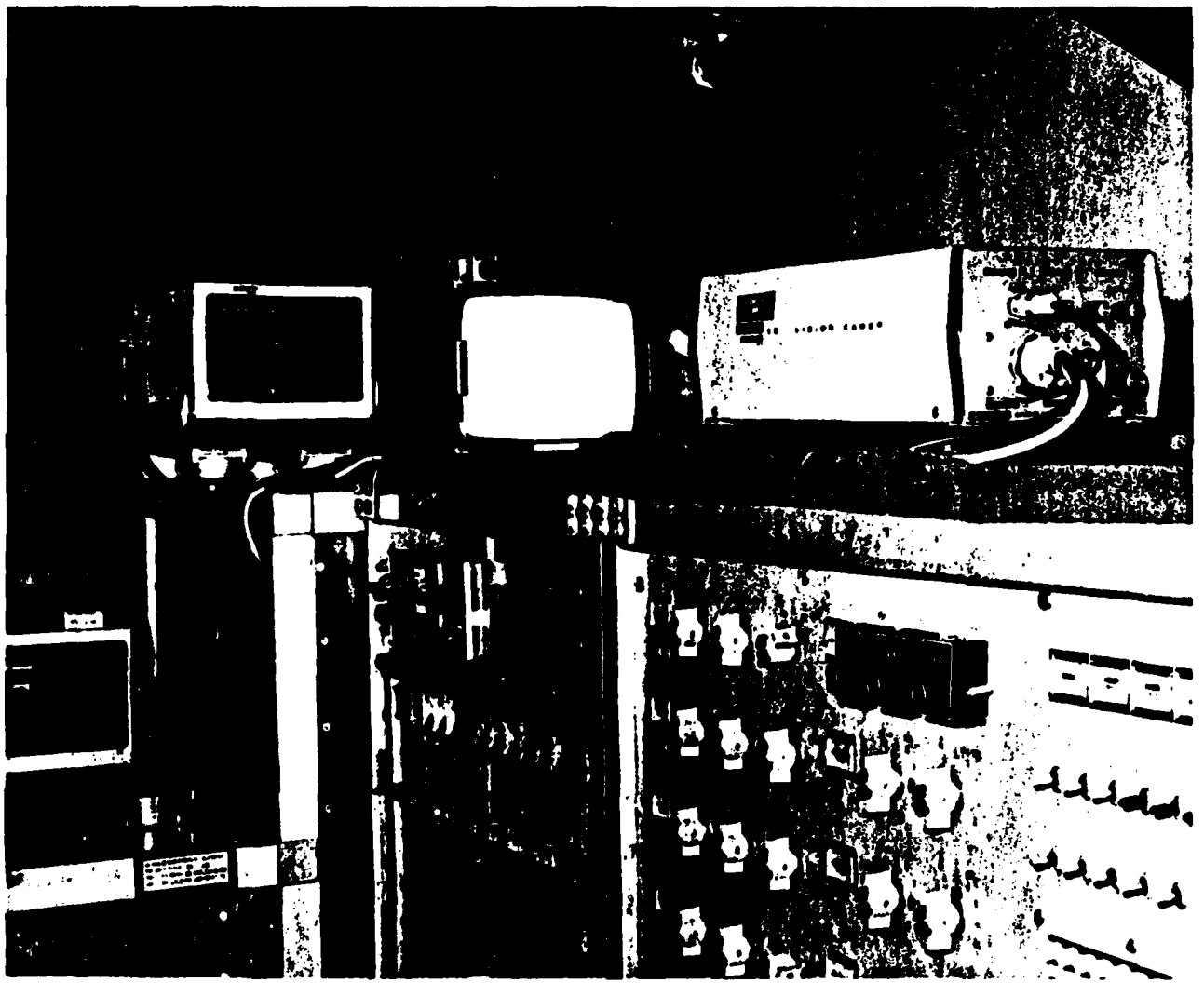


Figure 5 VIDEO CAMERA, XYTRON REPEATER AND VIDEO RECORDER POWER SUPPLY

Figure 6 REAR VIEW OF REPEATER AND VIDEO POWER SUPPLY

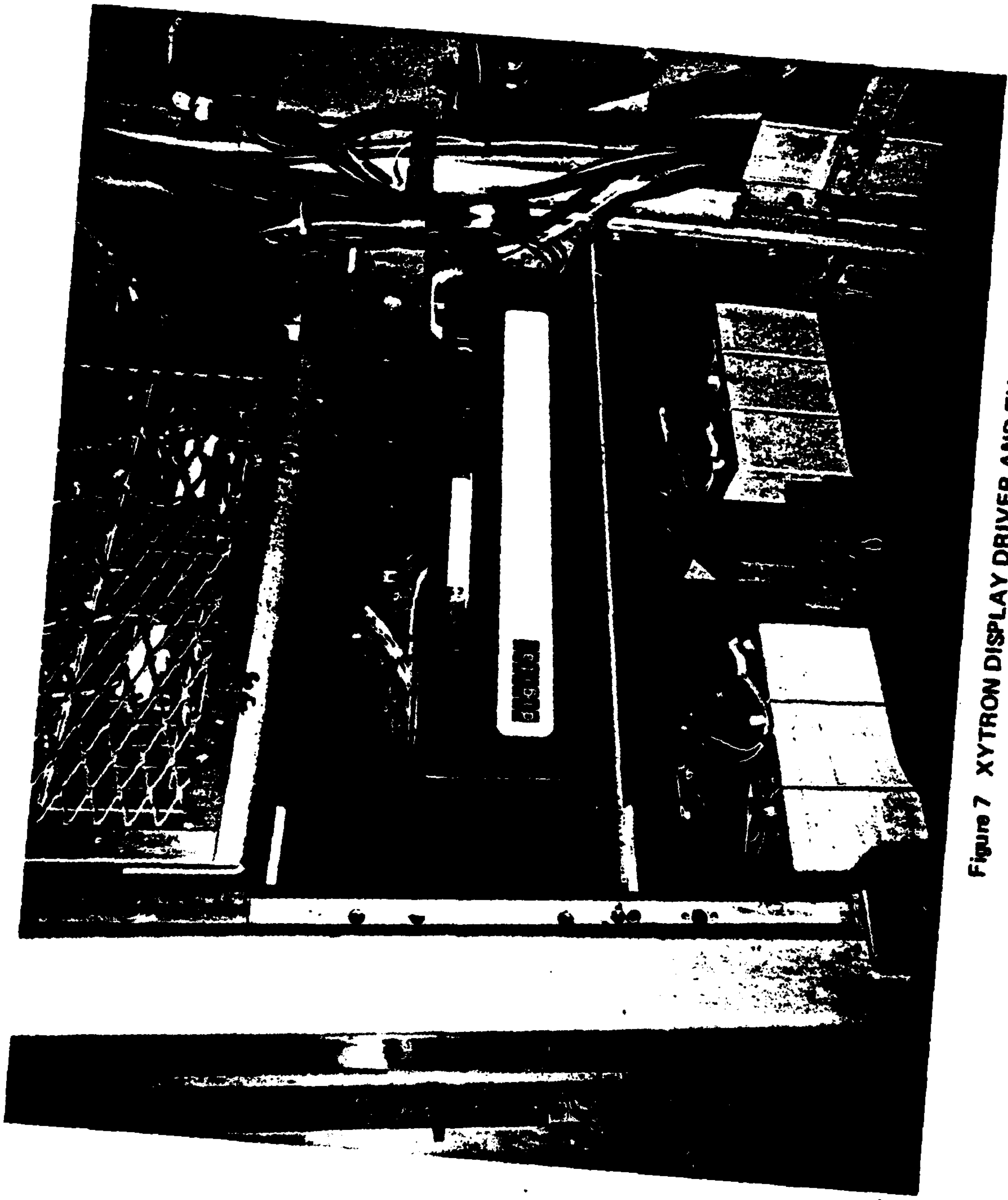


Figure 7 XYTRON DISPLAY DRIVER AND TU-58

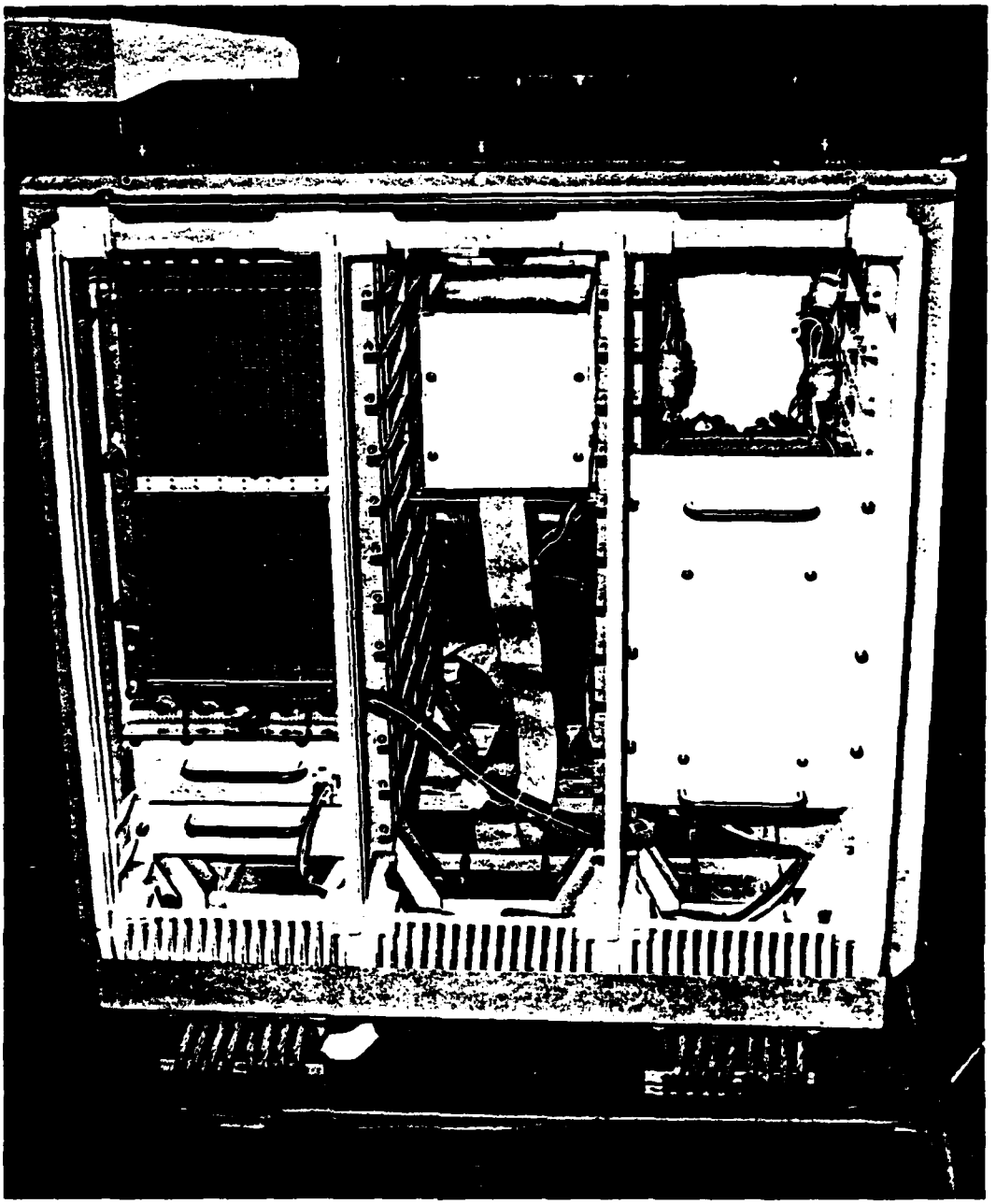


Figure 8 GRAPHICS PROCESSOR (PS-300) LOOKING FORWARD

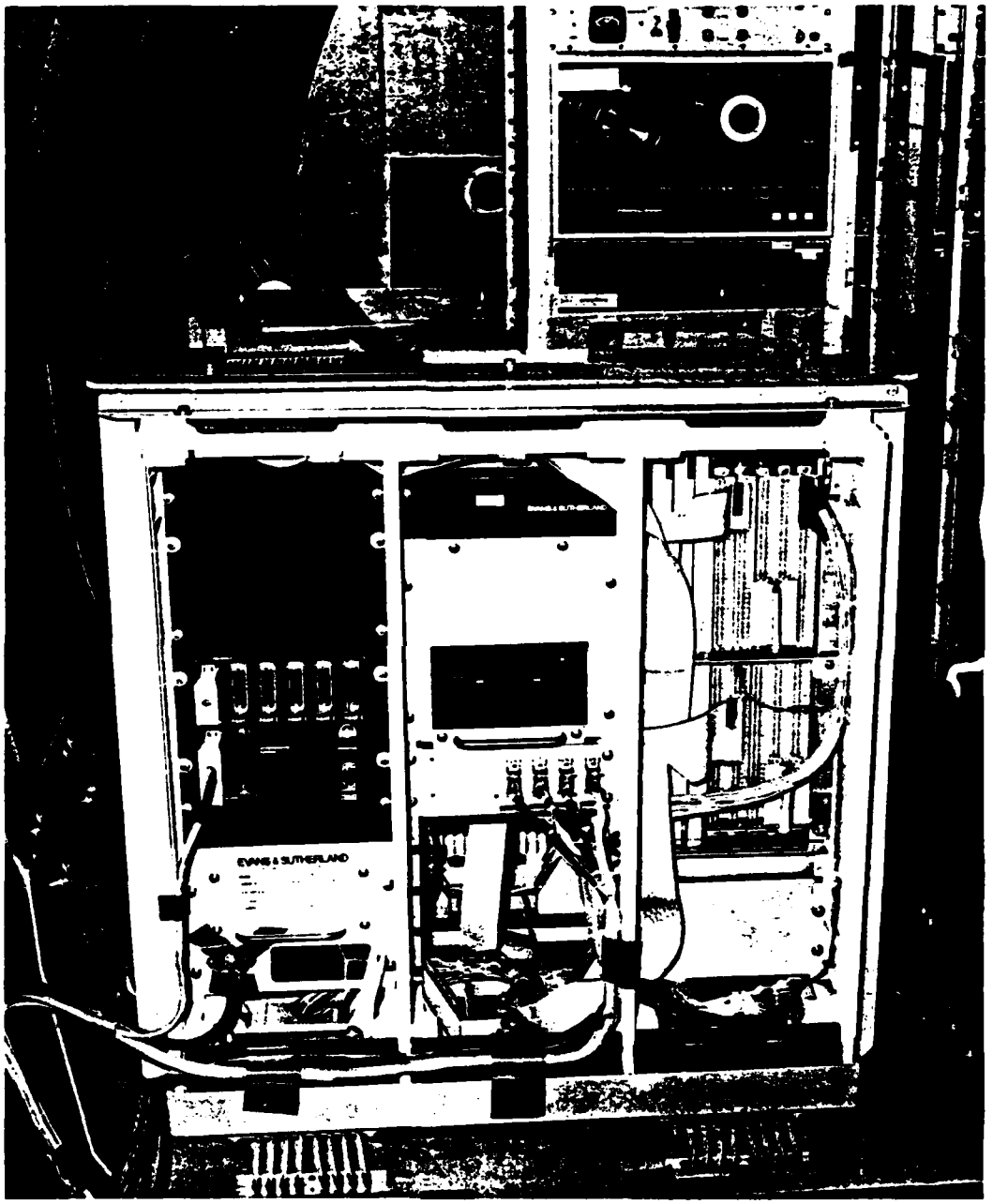


Figure 9 GRAPHICS PROCESSOR (PS-300) LOOKING AFT

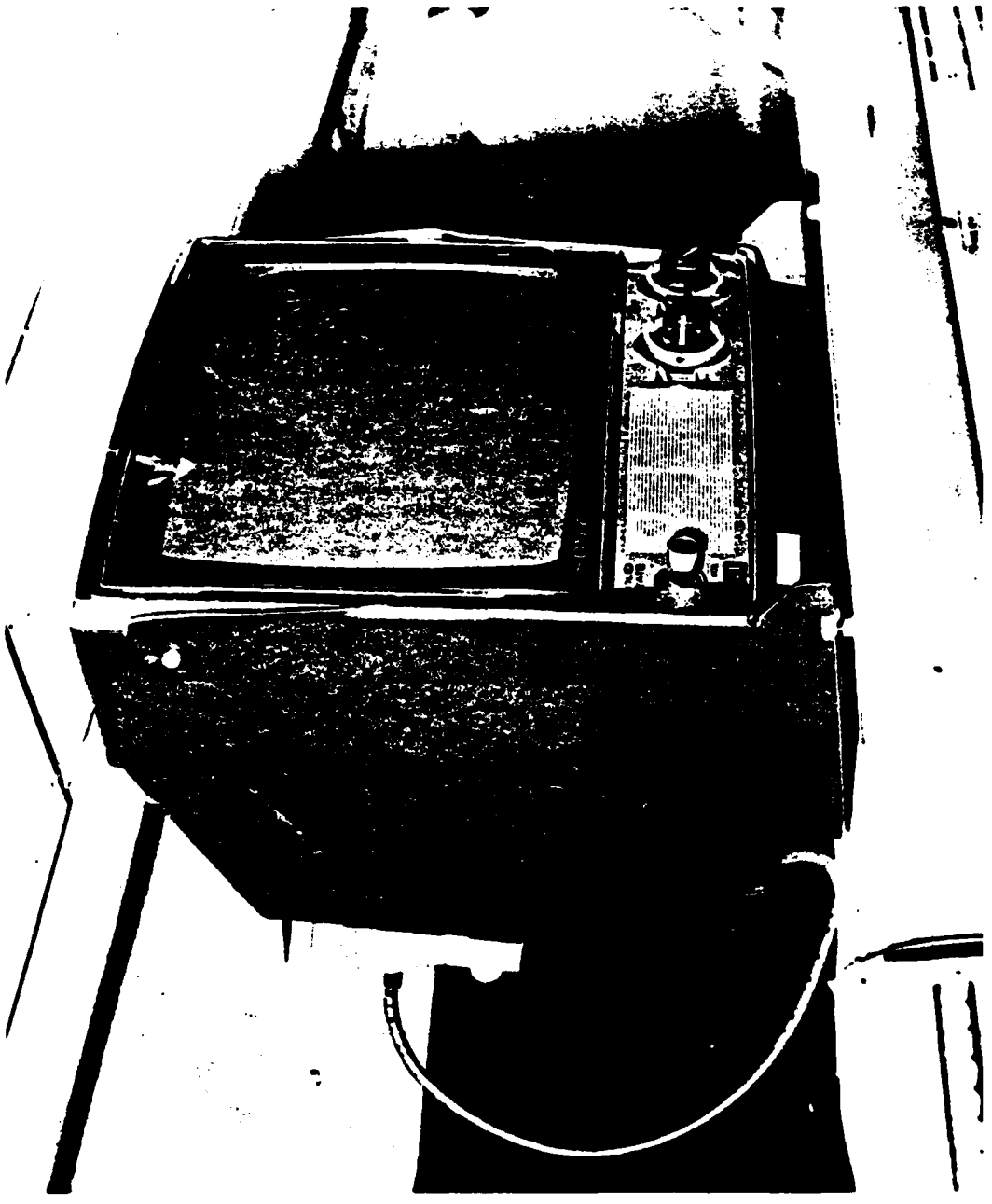


Figure 10 VIDEO MONITOR

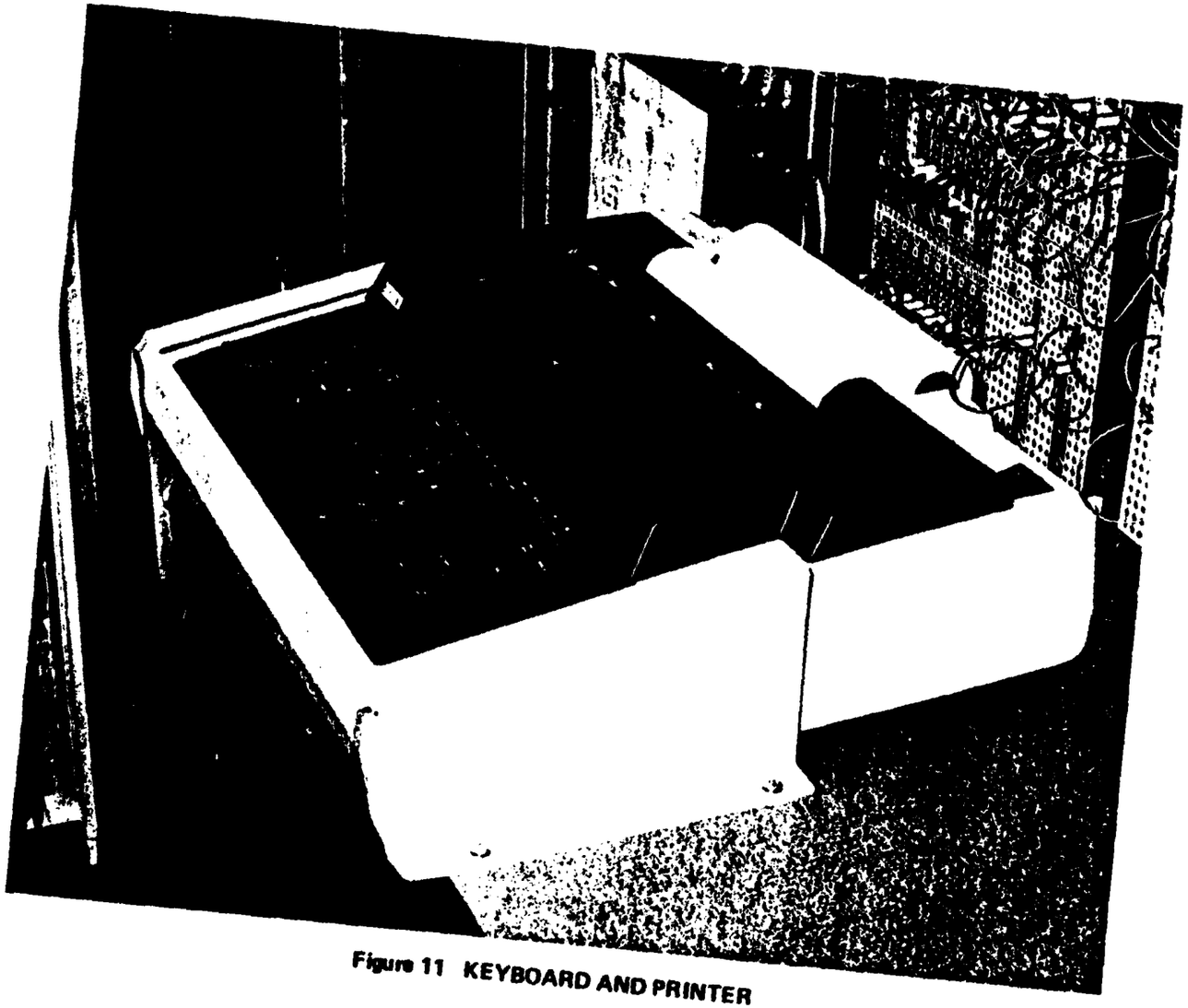


Figure 11 KEYBOARD AND PRINTER

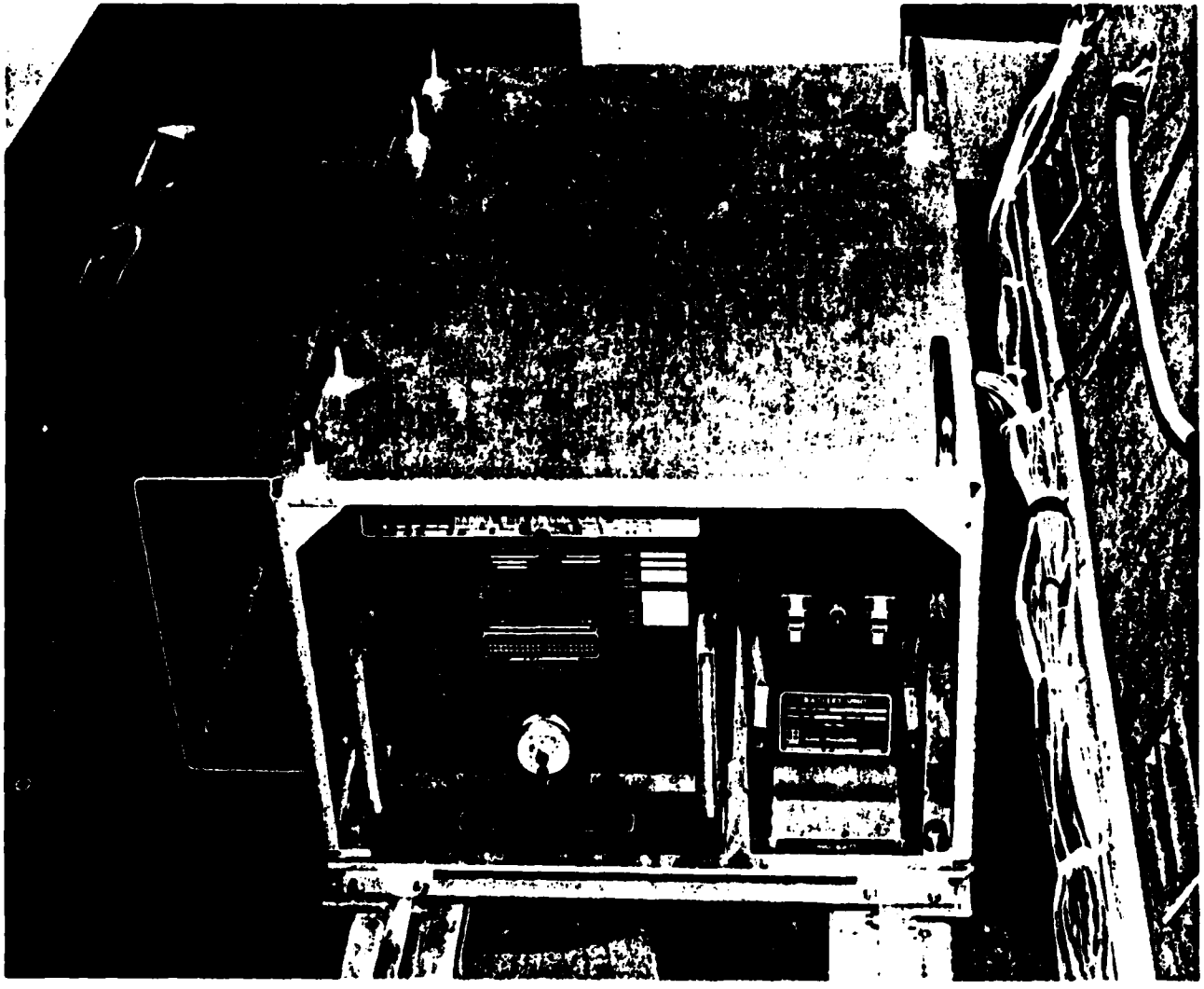


Figure 12 INERTIAL NAVIGATION UNIT (LTN-72) LOOKING FORWARD

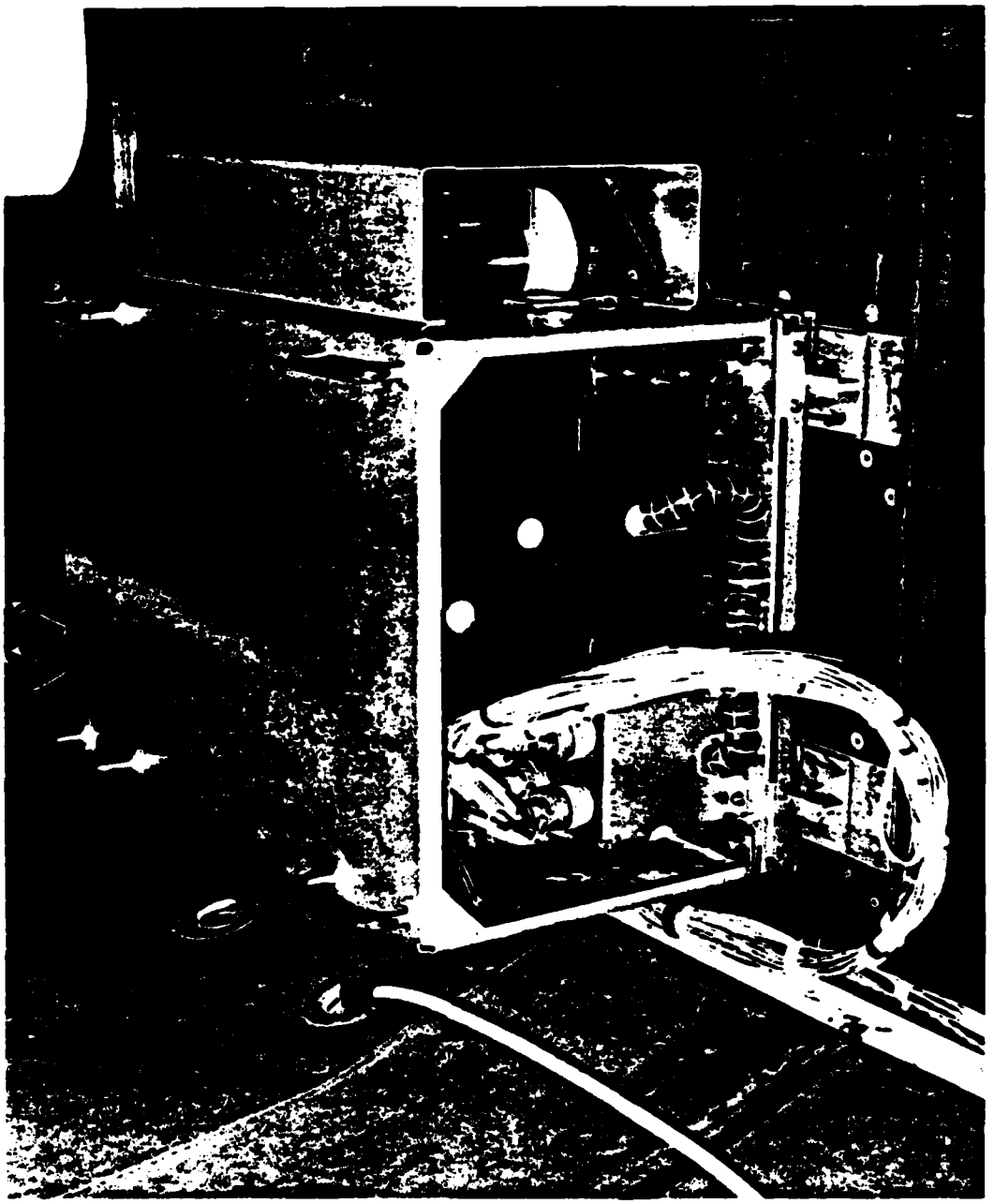


Figure 13 INERTIAL NAVIGATION UNIT LOOKING AFT

Figure 14 CONTROL/DISPLAY FOR INU

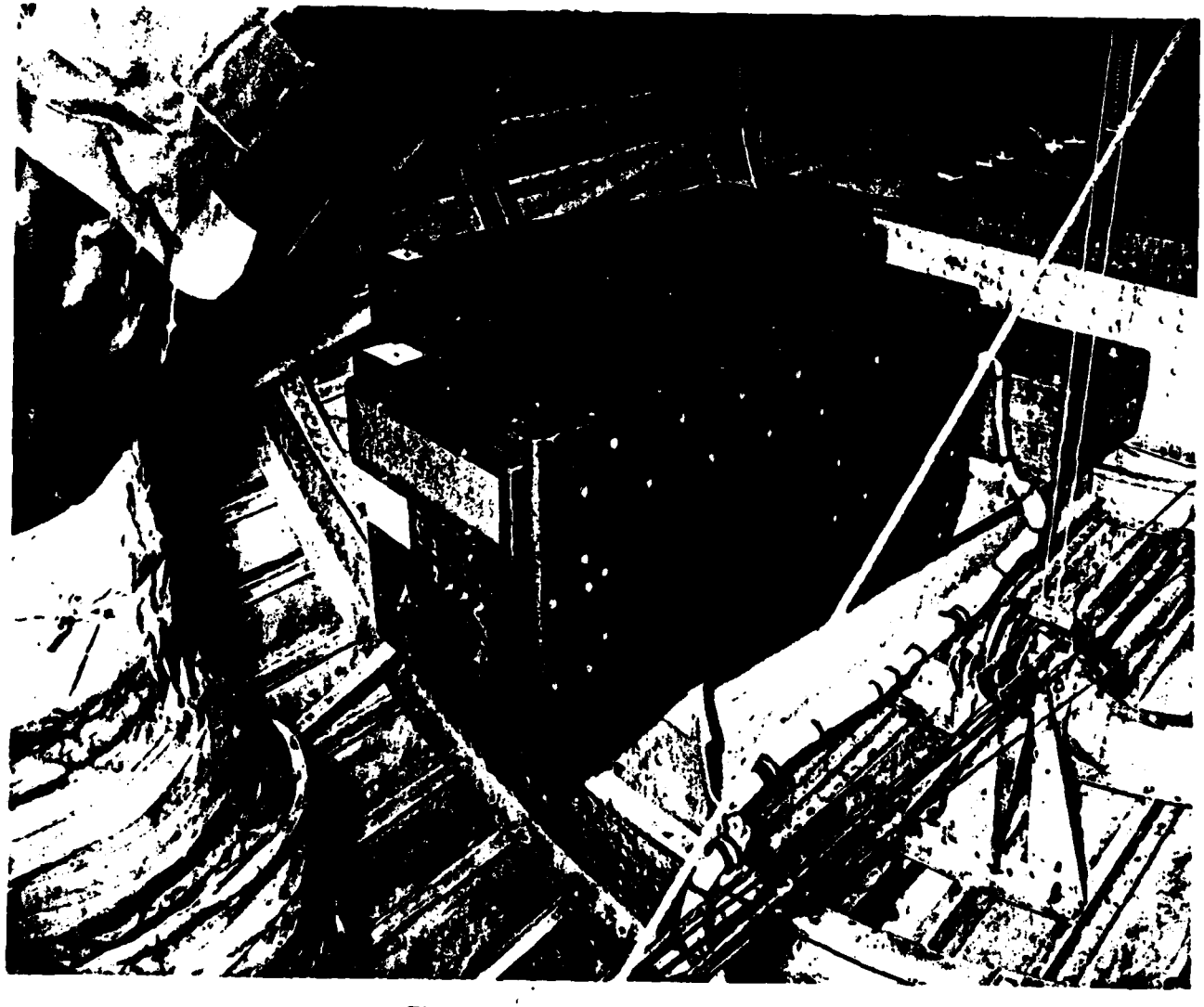


Figure 15 60 HERTZ CONVERTERS

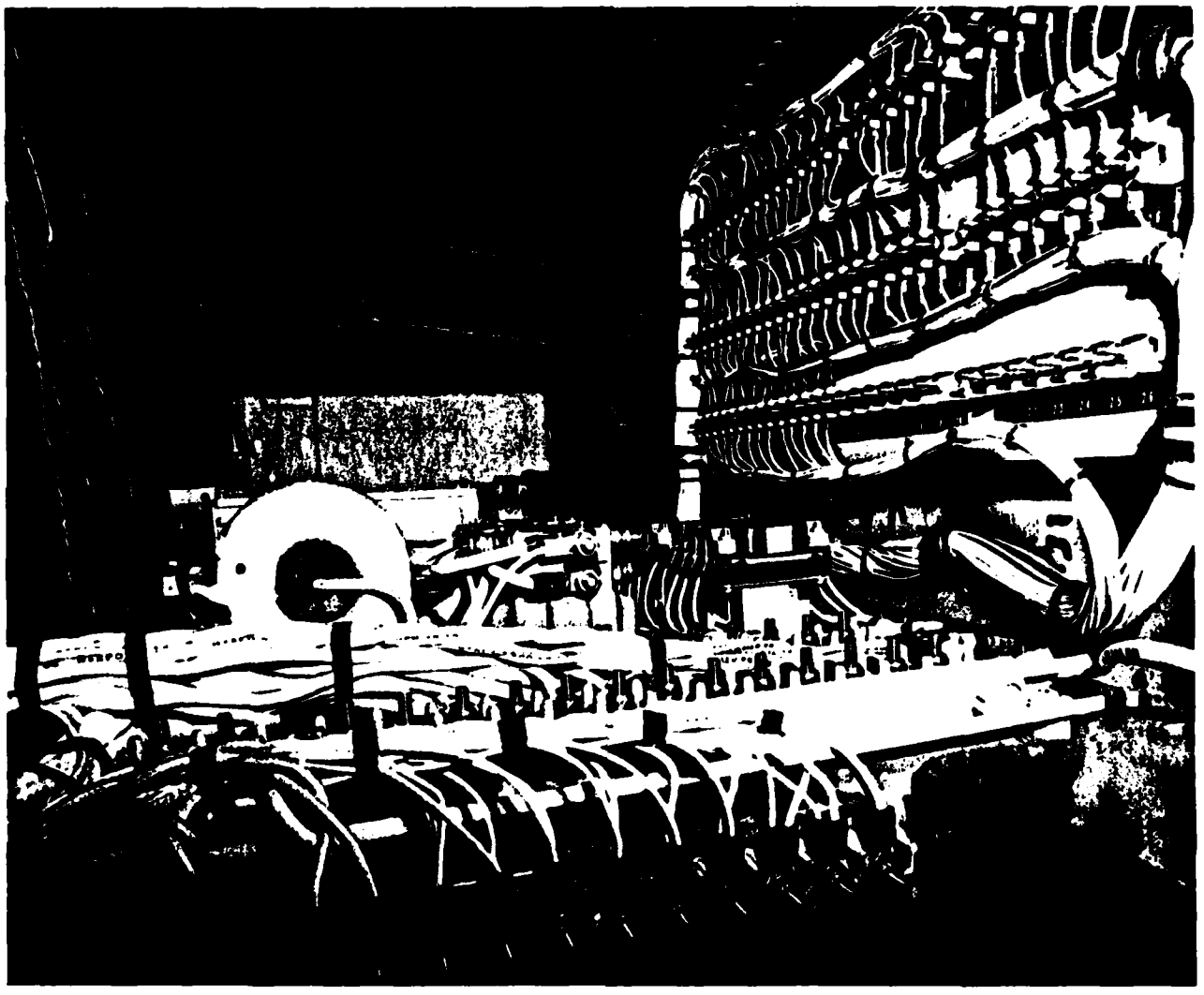


Figure 16 60 HERTZ FILTER CHASSIS

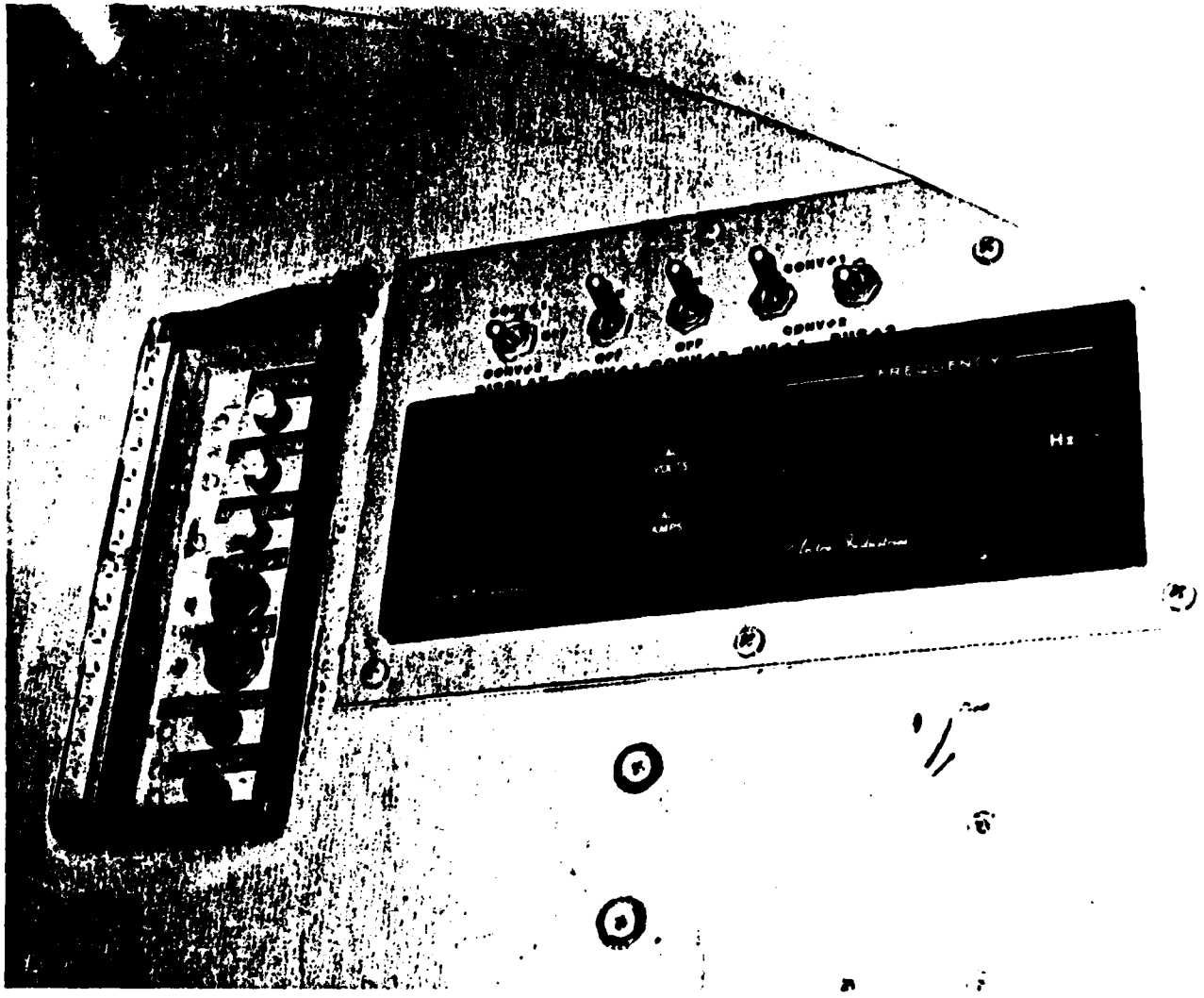


Figure 17 60 HERTZ MONITOR/CONTROL PANEL